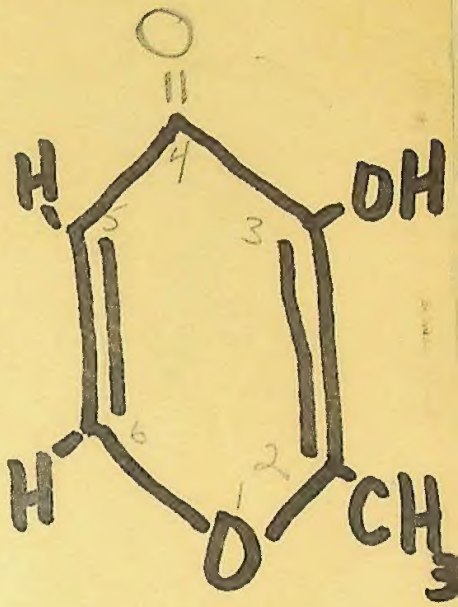
426/658

'0 Literature

MALTOL in Foods

2,955,041	99/140
3,015,654	99/140
3,054,805	269/345.9
3,130,204	99/140
3,133,089	260/345.9
3,156,569	99/140
3,159,652	99/140
3,171,842	260/345.9
3,186,853	99/140 UXR
3,293,045	99-134
3,296,079	167-93
3,338,718	99-2
3,365,469	260-345.9
3,376,317	260-345.9
3,409,441	99-28



3-11-66 S.E.M. (J.G.)

Maltol, also called 2-methyl-3-hydroxy gamma (γ) pyrone

Chem Abs. Search

—1956 Maltol

1956 — Pyranone

4H Pyran-4one, 3hydroxy-2methyl

MALTOL DIGEST

26. POTTER, F. E., and PATTON, S. Evidence of maltol and hydroxymethylfurfural in evaporated milk as shown by paper chromatography. J. Dairy Sci. 39: 978–982 (1956).
27. RASMUSSEN, R. S., TUNNICLIFF, D. D., and BRATTAIN, R. R. Infrared and ultraviolet spectroscopic studies on ketones. J. Am. Chem. Soc. 71: 1068–1072 (1949).
28. REICHSTEIN, T., and BEITTER, H. Die Zusammensetzung der Aromastoffe von gerösteter Cichorie. Berichte 63: 816–826 (1930).
29. SCHENCK, J. R., and HOFELMAN, M. V. The formation of maltol by the degradation of streptomycin. J. Am. Chem. Soc. 67: 2276–2277 (1945).
30. SHERMAN, H. C. A source of error in the examination of foods for saccharic acid. J. Ind. Eng. Chem. 2: 24–25 (1910).
31. SINGH, B., DEAN, G. R., and CANTOR, S. M. The role of 5-(hydroxymethyl) furfural in the discoloration of sugar solutions. J. Am. Chem. Soc. 70: 517–522 (1948).
32. STENHOUSE, J. Ueber Larixinsäure, einen krystallisirbaren flüchtigen Bestandtheil der Rinde des Lerchenbaums (Pinus larix L.). Ann. Chem. Liebigs 123: 191–199 (1862).
33. SULLIVAN, BETTY, and PAYNE, W. E. The amino acids of the water extract of flour. Cereal Chem. 28: 340–342 (1951).
34. WEYGAND, F., and CSENDES, E. Eine Nachweismethode für Endiole und Enole der 1,3-Diketone. Chem. Ber. 85: 45–57 (1952).
35. WEYGAND, F., SIMON, H., and BITTERLICH, W.; HODGE, J. E., and FISHER, B. E. Structure of piperidino-hexose-reductone. Tetrahedron 6: 123–138 (1959).

FLAVOR OF BREAD AND PASTRY UPON ADDITION OF MALTOL, ISOMALTOL, AND GALACTOSYLISOMALTOL[1]

J. E. HODGE AND HELEN A. MOSER

ABSTRACT

A chemical method of preparing isomaltol developed recently in the Northern Laboratory has permitted for the first time extensive investigation of this compound. Similarity of the odor of isomaltol to the fragrant, caramel-like odor of maltol prompted a flavor comparison of the two compounds in aqueous and breadlike media. Both compounds have been reported as minor constituents of bread.

Taste panel results show that maltol and isomaltol give similar caramel-like flavors, sometimes described as fruity. Isomaltol is generally described as sweeter, less bitter, weaker, and, at times, less pleasant than maltol. When each is incorporated in yeast rolls at 0.1% of the flour weight, flavor difference in the breads is frequently detected. The flavor is described as similar to that of the control fresh bread, only stronger. Isomaltol is the more volatile, and much of it is lost during baking.

The β-D-galactoside of isomaltol, easily prepared from milk sugar, has a bitter taste. In fermenting doughs, it is split into isomaltol and galactose and, in some baking pastries, by heat and moisture. Pie crust that contained 0.5% *O*-galactosylisomaltol before baking was preferred by tasters over the control.

Maltol (3-hydroxy-2-methyl-4-pyrone) and isomaltol (structure not

[1]Manuscript received July 29, 1960. Contribution from the Northern Regional Research Laboratory, Peoria, Illinois. This is a laboratory of the Northern Utilization Research and Development Division, Agricultural Research Service, U.S. Department of Agriculture. Presented at the 15th annual meeting, Chicago, Illinois, May 1960. See footnote to companion paper, Hodge and Nelson, p. 207.

proved) are volatile, crystalline, enolic compounds ($C_6H_6O_3$) that have been isolated in trace amounts from baked cereals and breads (1,2,3,12). Maltol is the better known and is sold commercially as a flavoring agent. Isomaltol was discovered and isolated by Backe in 1910 (1,2) from a bread made with special flour containing condensed milk (biscuit powder[2]). Backe also demonstrated the presence of isomaltol (or maltol!) in other wheat breads by means of the characteristic purple color reaction that isomaltol (also maltol) gives with ferric chloride (1).

Patton isolated maltol from heated milk (7,11) and also from autoclaved solutions of maltose or lactose and glycine (8). Glucose or galactose did not yield maltol under the same conditions. Condensed milk containing lactose-1-C^{14} gave radioactive maltol (9,10). Hodge and Nelson isolated *O*-galactosylisomaltol and isomaltol from alcoholic solutions of lactose heated with secondary amine salts (5), but glucose, galactose, mannose, or fructose did not yield isomaltol under the same conditions (4,6). It appears that maltol and isomaltol arise from the reducing glucose radicals in maltose and/or lactose by interaction with amino groups during the baking of bread.

Backe did not report an odor for isomaltol, *per se*; he reported that isomaltol gives rise to a strong, fragrant odor on oxidation with permanganate, silver oxide, Fehling solution, or treatment with formalin. Hodge and Nelson found that pure isomaltol has a palpable odor[3]. Similarity of isomaltol odor to the fragrant, caramel-like odor of maltol prompted this comparison of their flavors in aqueous and breadlike media by a taste panel.

Materials and Methods

Materials. Isomaltol and *O*-galactosylisomaltol were prepared by the method of Hodge and Nelson (5), and each was recrystallized from water until it was colorless. The commercial product "Palatone"[4], a specially purified form of maltol, m.p. 162°C., was used.

Tests on Aqueous Solutions. Potassium permanganate was added to distilled water; the pink solution was distilled and then redistilled in all-glass apparatus. This water was aerated and used to make the maltol, isomaltol, and *O*-galactosylisomaltol solutions and as a mouth wash for the tasters. Because 0.2% isomaltol solutions at pH 3.7 are definitely sour and astringent, both maltol and isomaltol solutions were neutralized to pH 6.0 with 5% sodium bicarbonate solution. The

[2] Nestlé's food (farine lactée), a powdered preparation of wheat flour and condensed milk.

[3] A more penetrating, fragrant, phenolic, or aromatic aldehyde odor is prominent during the distillation of isomaltol when a yellow substance codistills, as in the pyrolysis of *O*-galactosylisomaltol. A similar odor is produced by permanganate oxidation and by boiling solutions of isomaltol in 20% sodium hydroxide; hence, this odor is probably the one observed by Backe (2).

[4] The mention of trade products does not imply that they are endorsed or recommended by the Department of Agriculture over similar products not mentioned.

isomaltol solutions were golden yellow at pH 6, whereas the maltol solutions were colorless. Therefore, lighting in the taste-panel room was adjusted to eliminate the color difference. Solutions were tasted under conditions which were as free as possible from extraneous distractions. Individual booths provided privacy, and temperature (25°C.) and humidity (40%) were kept constant.

Each treated sample was compared with a control at two test sessions: the treated sample was tasted first at one session and second at the other. The number of tasters at each session varied from 12 to 20, but the same group of people was used throughout the tests. Instructions were to describe odor, taste, and any difference in taste between the control and treated samples, and then to state a preference. The voluntary answers were grouped (sweet, sour, stale, flat, bitter, like fresh bread, etc.), and the responses under each group were totaled for both test sessions.

Preparation and Tests on Yeast Rolls. To conserve time and materials and to give more crust surface per unit volume, small yeast rolls were baked instead of loaf bread. Yeast rolls were prepared by the following recipe:

½ tbsp. sugar ⅛ tsp. salt ⅛ tbsp. fat (margarine) the additive, when used	in 2 tbsp. boiling water
1½ tbsp. egg	
½ tsp. yeast in ½ tbsp. warm water	
½ cup flour (56.5 g.)	

The percentage of additive used in each test was based on the weight of the flour. After the first rising, the dough was made into rolls which were set to rise again until doubled in bulk (about 1 hour) and then were baked for 10 minutes at 218°C. Odor during baking was observed at the oven vents and upon first opening the oven door. Samples were presented to the taste panel in covered beakers at 55°C. under lighting controlled to obscure color differences[5].

Preparation and Tests on Pie Crust. Pie crust, prepared in the usual way from 62.5 g. wheat flour, 36.0 g. shortening (hydrogenated vegetable oil), and 15.0 ml. cold water, was mixed and rolled to ⅛-in. thickness. Cut strips were baked at 260°C. for 8 minutes. *O*-Galactosylisomaltol was added at a selected percentage of the flour weight. Selected strips of pie crust of the same degree of brownness were presented to the panel in covered beakers at 55°C.

Test for Maltol and Isomaltol in Baked Products. To determine roughly the amount of maltol or isomaltol remaining in the baked

[5] Pumpkin-pink color was noted in the rolls that contained maltol, both before and after baking.

products. 2-g. samples were pulverized under 10 ml. of 50% aqueous ethanol in test tubes. After the triturated sample had stood in the alcohol for 30 minutes, 5 ml. of the clear supernatant liquor were decanted and tested for the enolic hydroxyl group of the additive with 3 drops of 3% ferric chloride solution in 95% ethanol. In some cases, the supernatant liquor had to be decanted and centrifuged. According to the depth of color formed, concentrations were estimated as *strong*, *medium*, *weak*, or *negative*.

Results and Discussion

Tests on Aqueous Solutions. Results of flavor evaluations on isomaltol and maltol at 0.2 and 0.5% concentrations in doubly distilled water neutralized to pH 6, are recorded in Table I. Differences in intensity of the flavors were specified by the panel as follows: maltol

TABLE I

FLAVOR OF ISOMALTOL AND MALTOL IN WATER
(Neutralized to pH 6 with sodium bicarbonate)

FLAVOR DESCRIPTIONS	31 TASTERS		20 TASTERS	
	Isomaltol, 0.2%	Maltol, 0.2%	Isomaltol 0.5%	Maltol 0.5%
Burnt sugar, caramel	8	13	10	10
Fruity*	7	6	4	2
Sweet	9	0	6	1
Sour	2	3	4	6
Bitter	2	12	4	11
Stale, metallic, rusty	3	3	1	1
Malty	0	0	1	0
Salty	1	0	1	0
Flat, tasteless	2	0	1	0

*Fruit mentioned: apple, cherry, melon, plum, strawberry, fruit pie, and artificial fruit flavor.

has the stronger caramel-like odor and taste and is much more bitter, isomaltol is sweeter and slightly more fruity. Although both isomaltol and maltol solutions were neutralized with sodium bicarbonate, only two of fifty-one tasters thought the soda solutions were salty. Sourness was specified even though the solutions were at pH 6.

Tests on Yeast Rolls. Isomaltol and maltol, separately incorporated in yeast roll dough at 0.1% of the flour weight, imparted a fruity odor before baking and a sweeter, more intense, fresh-bread odor during baking. Isomaltol gave, in addition to the fruity-caramel, fresh-bread odor, an unpleasant overtone described as medicinal and grassy; maltol gave an entirely pleasing and stronger odor. The maltol-treated dough wetted more readily and gave slightly increased volume in the bread over the control. Color of the isomaltol-treated dough was not noticeably different from the control; however, in direct visual com-

TABLE II

FLAVOR TESTS ON YEAST ROLLS: ISOMALTOL VS. CONTROL

FLAVOR DESCRIPTIONS (34 Testers)	CONTROL	ISOMALTOL, 0.1%
Odor		
Fresh bread	12	21
Yeasty, doughy	15	6
Stale, musty, moldy	2	4
Sweet	0	3
Taste		
Fresh bread	12	16
Sweet	3	5
Sour	3	2
Stale, musty	5	2
Salty	2	0
Cucumber	0	1
Preference (No preference: 4)	13	17
Reason: More fresh-bread flavor	8	10
Sweeter, less off-flavor	4	7

parison, the treated bread reflected less light. Maltol-treated dough was consistently and decidedly pinkish orange or pumpkin-colored. Color intensity diminished on baking, but still was quite noticeable in comparison with the control bread. Results of flavor evaluations are given in Tables II, III, and IV.

Isomaltol in yeast rolls gave a fresh-bread odor and reduced the yeasty, doughy odor of the control roll but slightly increased its sweetness. On the other hand, musty overtones were detected by some, and this fact probably is responsible, in part, for lack of preference for the treated roll. The ferric chloride test on an alcoholic extract of the

TABLE III

FLAVOR TESTS ON YEAST ROLLS: MALTOL VS. CONTROL

FLAVOR DESCRIPTIONS (36 Testers)	CONTROL	MALTOL, 0.1%
Odor		
Fresh bread	13	18
Yeasty, doughy, sour	16	11
Stale, musty, moldy	6	4
Sweet	0	5
Taste		
Fresh bread	15	21
Sweet	5	5
Sour, fermented	7	2
Stale, musty	3	0
Flat, bland	3	4
Bitter	3	3
Preference (No preference: 2)	12	22
Reason: More fresh-bread flavor	9	9
Sweeter, less off-flavor		14

baked roll was judged *weak*, hence little isomaltol remained to giv flavor.

Maltol in yeast rolls give a decidedly fresher, more pleasing flavo according to the panel (Table III), than the control rolls which the judged sour, stale, and musty in comparison. The enol test was *strong* showing that much of the maltol remained in the roll.

TABLE IV

FLAVOR TESTS ON YEAST ROLLS: ISOMALTOL VS. MALTOL

FLAVOR DESCRIPTIONS	16 TASTERS		17 TASTERS	
	Isomaltol, 0.1%	Maltol, 0.1%	Isomaltol, 0.2%	Maltol, 0.2%
Odor				
Fresh or normal bread	7	7	7	12
Yeasty	5	4	1	6
Sweet	3	1	1	2
Sour, sharp	1	2	2	0
Stale, musty	2	1	4	0
Crackers	1	0	0	0
Taste				
Fresh or normal bread	9	6	10	11
Yeasty	2	2	0	3
Sweet	1	3	5	4
Stale, musty	3	1	3	0
Flat, bland	1	3	1	3
Fatty, buttery	1	0	1	1
Nutty	0	0	2	0
Melony, cucumber	1	0	1	0
Preference*	6	9	5	11
Reason: More flavor	3	4	2	1
Sweeter, less off-flavor	2	3	3	10
Very little difference	1	2	1	0

*No preference expressed by one taster at each session.

In flavor comparisons of isomaltol against maltol (Table IV), the maltol-treated rolls were preferred. The results show again that isomaltol diminishes yeasty odor and taste, but accompanying mustiness reduces acceptability. Ferric chloride tests on the finished rolls again showed *weak* enolic content for isomaltol-treated rolls and *strong* enolic content for maltol-treated rolls. Evidently isomaltol steam-distills to a much greater extent than maltol during baking. When the initial isomaltol concentration was doubled to 0.2%, the enol content was still much less than the enol content of the 0.1% maltol-treated roll by the ferric chloride test. The greater preference for maltol, therefore, can be attributed to its higher concentration in the finished bread and to its being free from musty, stale off-flavors.

Because *O*-galactosylisomaltol is a beta-galactoside readily split by almond emulsin to galactose and isomaltol (5), tests were made to

determine whether an active beta-galactosidase is contained in yeast rolls. Dough containing 0.3% *O*-galactosylisomaltol was allowed to rise normally. Ferric choloride tests on the risen dough showed purple color and *medium* enol content. Therefore, flavor evaluations were made on such treated rolls baked, as before, at 218°C. Table V shows that preference was slightly less for these rolls than for the control

TABLE V

O-GALACTOSYLISOMALTOL IN WATER, YEAST ROLLS, AND PASTRY

MEDIUM	TEST NO.	CONCENTRATION	TASTERS	FLAVOR RESPONSE	
		%	*No.*		
Water					
Doubly distilled, pH 6	1	0.15	16	Tasteless	11
				Bitter	4
				Sour	1
	2	0.50	19	Tasteless	4
				Bitter	13
				Sour	2
				Preference over Control	
Yeast rolls				%	
Baked at 218°C[a]	1	0.30	16	43	
	2	0.50	19	47	
	3	0.50	14	46	
Pie crust					
Baked at 260°C[b]	1	0.50	14	69	
	2	0.50	18	83[c]	
	3	0.50	17	60	

[a] Enol test *medium* in dough, *weak* after baking.
[b] Enol test *weak* after baking.
[c] Significant at the 5% level.

bread. Table V also shows that the flavor of *O*-galactosylisomaltol at 0.5% concentration in water is decidedly bitter. However, bitterness was not detected in treated rolls; the evaluation was generally the same as for the controls, but with more "sweet" responses. In every case, the treated rolls browned more than the controls. The enol tests were *negative* (or very weakly positive), so it is concluded that the galactoside was split to galactose and isomaltol but that the isomaltol was almost completely distilled from the bread. The liberated galactose remained and gave rise to greater browning by caramelization and/or the Maillard reaction.

Tests on Pastry. Because *O*-galactosylisomaltol melts and decomposes with the sublimation of isomaltol around 200°C. (5), pie crust with a baking temperature of 260°C. was selected as a substrate for splitting the galactoside *in situ*. When water-recrystallized *O*-galactosylisomaltol in the low-melting crystalline form (m.p. about 190°C.) was used, ferric chloride tests showed *weak* to *medium* enolic contents in the finished

pie crust. Preferences were for the treated pie crust (Table V), although only one of three tests showed significance at the 5% level. Reasons for the preference were given by panel members as more baked flavor (biscuit, cracker) and less lardy, doughy, or rancid flavor. Whereas more baked flavor could have arisen by carmelization of the reducing sugar released, diminution in lardy and doughy flavor is the same response received for isomaltol alone in yeast rolls (Tables II and IV). More tests are needed to relate the preference to the galactose or isomaltol moieties individually, or to them both.

Results of all tests show that incorporation of maltol, isomaltol, and *O*-galactosylisomaltol in baked goods may significantly improve their acceptance. The concentrations of isomaltol and maltol in ordinary breads have not been determined. With isomaltol now available as a reference compound, and with this demonstration that isomaltol and maltol *can* be contributing components to fresh-bread odor and flavor, modern methods of analysis can be used to determine the importance of these compounds among the many volatile constituents that contribute to bread flavor.

Acknowledgments

The assistance of twenty faithful members of the taste panel is gratefully acknowledged. This work was done under the general supervision of C. D. Evans, R. J. Dimler, and C. E. Rist. The highly purified maltol was a gift from The Dow Chemical Company, Midland, Michigan.

Literature Cited

1. Backe, A. Sur un nouveau composé contenu dans les produits alimentaires. Compt. rend. 150: 540–543 (1910).
2. Backe, A. Recherches sur l'isomaltol. Compt. rend. 151: 78–80 (1910).
3. Drews, E. Weitere Einsatzmöglichkeiten der Papierchromatographie auf dem Bäckereisektor. Brot u. Gebäck 12(6): 138–140 (1958).
4. Hodge, J. E. Novel reductones and methods of making them. U.S. Patent 2,936,308 (May 10, 1960).
5. Hodge, J. E., and Nelson, E. C. Preparation and properties of galactosylisomaltol and isomaltol. Cereal Chem. 38: 207–221 (1961).
6. Hodge, J. E., Nelson, E. C., and Fisher, B. E. Reductones from reactions of sugars with amine salts. J. Org. Chem. (in preparation).
7. Patton, S. The isolation of maltol from heated skim milk. J. Dairy Sci. 33: 102–106 (1950).
8. Patton, S. The formation of maltol in certain carbohydrate-glycine systems. J. Biol. Chem. 184: 131–134 (1950).
9. Patton, S. Review of organic chemical effects of heat on milk. J. Agr. Food Chem. 6: 132–135 (1958).
10. Patton, S., and Flipse, R. J. Carbon-14 activity of some heat-degradation products of milk containing lactose-1-C^{14}. Science 125: 1087–1088 (1957).
11. Potter, F. E., and Patton, S. Evidence of maltol and hydroxymethylfurfural in evaporated milk as shown by paper chromatography. J. Dairy Sci. 39: 978–982 (1956).
12. Sherman, H. C. A source of error in the examination of foods for salicylic acid. Ind. Eng. Chem. 2: 24–25 (1910).

United States Patent Office

2,955,041

Patented Oct. 4, 1960

2,955,041

FLAVORING AGENTS AND PROCESS FOR IMPARTING A MEAT-LIKE FLAVOR TO AN EDIBLE COMPOSITION

James J. Broderick, River Edge, and Lino L. Linteris, Demarest, N.J., assignors to Lever Brothers Company, New York, N.Y., a corporation of Maine

No Drawing. Filed Dec. 11, 1958, Ser. No. 779,536

7 Claims. (Cl. 99—140)

This invention is concerned with novel processes for imparting a meat-like flavor to edible materials, and with compositions which have been given a meat-like flavor by incorporating in them small amounts of certain derivatives of mercapto-acetaldehyde.

It is well known that each type of meat has its own unique flavor. At the same time, however, it is also recognized that a great similarity exists between the flavors of various types of meat. For example, a person tasting a particular kind of meat for the first time would be able to identify the flavor as that of some kind of meat, although he would not be able to identify the particular kind of meat. It may therefore be said that there exists a basic flavor fundamental to most, if not all, kinds of meat, and the individual flavors of particular types of meat are variations of the one basic flavor.

It has now been discovered that it is possible to impart a basic meat-like flavor to meatless edible compositions. Such a result is accomplished by adding to the meatless composition small amounts of certain stabilized derivatives of mercapto-acetaldehyde.

Mercapto-acetaldehyde, as its name indicates, possesses a mercapto group and an aldehyde group. The derivatives of mercapto-acetaldehyde used in the present invention are those in which at least one of the functional groups of the compound is involved in an acetal type linkage. The acetal type linkage may be at either of the functional groups, i.e. the mercapto group of the mercapto-acetaldehyde may be linked to the aldehyde group of another compound, or the aldehyde group of the mercapto-acetaldehyde may be linked to the alcohol or mercapto group of another compound. It is to be understood that the expression acetal type linkage includes not only acetal linkages per se, but also hemi-acetals, mercaptals, and hemi-mercaptals. The compounds useful for forming the acetal type linkage with the mercapto-acetaldehyde are alcohols, mercaptans and aldehydes having from 1 to 5 carbon atoms. The formation of the acetal type linkage is thought to confer on the mercapto-acetaldehyde molecule stability needed to be useful in the invention.

Some of the derivatives of mercapto-acetaldehyde used in the present invention contain a free mercapto group. The sodium and the potassium salts of such free mercapto groups may be formed, and the resulting salts are also useful in the present invention.

Several compounds may be mentioned to illustrate useful stabilized derivatives of mercapto-acetaldehyde. The freshly prepared diethyl acetal of mercapto-acetaldehyde is a preferred compound, as are the hemi-mercaptals of mercapto-acetaldehyde. The mercapto group of one molecule of mercapto-acetaldehyde can react with the aldehyde group of another molecule of the compound and produce a dimer known as 2,5-dihydroxy-1,4-dithiane, which is also useful in the present invention. A particularly useful compound is that formed by the reaction between the mercapto group of mercapto-acetaldehyde and the aldehyde group of xylose.

The compounds of the present invention may be used individually or mixed with each other. They may also be used simultaneously with other flavor imparting materials. Flavor imparting materials useful in connection with the compounds of the present invention include such materials as sodium glutamate, protein hydrolyzates, spices, garlic, smoked flavors, aromatics such as capric acid and other fatty acids, thioaldehydes such as isovaleric thioaldehyde, ketones such as maltol, aldehydes such as propionaldehyde, phenols such as eugenol, and nitrogenous materials such as skatole and indole.

It is a distinct advantage of the present invention that the compounds used therein impart a fundamental meat-like flavor to which there can be added various known flavoring ingredients for specific effects. It is thus possible to obtain great flexibility in flavor, and to simulate the flavor of many specific types of meat.

Although the present invention is primarily of interest to impart meat-like flavor to meatless edible compositions, the invention may also be adopted to improving the flavor of meat or meat-containing compositions.

The compounds of the present invention may be used to impart flavor to many various types of foodstuffs, including meat substitutes, soups, sauces, sandwich spreads and the like. An example of such a material is a simulated meat product formulated from 20% vegetable oil and 14% vegetable protein, along with water. To this composition 2,5-dihydroxy-1,4-dithiane was added in amounts varying from 0.01 to 0.02%. The mixture was then autoclaved at 10 pounds' gauge pressure for 70 minutes. The resulting product had an agreeable, distinctly meat-like flavor.

It was found that the addition of minute amounts of a pentose, for example xylose, at a concentration of from about 0.015 to 0.07%, to the above composition increased the stability of the meat-like flavor.

In place of 2,5-dihydroxy-1,4-dithiane, other compounds of the invention such as the diethyl acetal of mercapto-acetaldehyde, hemi-mercaptals of mercapto-acetaldehyde or the xylose derivative of mercapto-acetaldehyde may be employed in a similar manner. In general, the preferred amount is from about 0.01 to about 0.06% by weight of the flavoring compounds in the composition, although a weak meat-like flavor may sometimes be obtained at concentrations as low as 0.005%.

The following examples are given solely for purposes of illustration and are not to be considered as limiting the invention to these embodiments. Many modifications will be apparent to those skilled in the art without departing from the spirit or scope of the invention.

EXAMPLES

The substances shown in Table II below were each added in the amounts stated to the corresponding numbered simulated meat product shown in Table I.

Table I

Ex. No.	75 I.V. Hydrog. Cottonseed oil	Unhydrog. Cottonseed oil	Soy Protein	Cracker Meal	Gelatin	Carboxymethyl cellulose	$Na_4P_2O_7$
1		25	15	1	1	0.2	0.2
2	20		15.9	1	1	0.35	0.2
3	20		15.9	1	1	0.35	0.2
4		25	15	1	1	0.2	0.2
5		25	15	1	1	0.2	0.2
6		25	15	1	1	0.2	
7		20	14.8	1	1	0.35	0.2
8		25	15	1	1	0.2	
9		20	14.8	1	1	0.35	0.2
10		20	14.8	1	1	0.35	0.2
11		20	14.8	1	1	0.35	0.2
12		20	14.8	1	1	0.35	0.2

Sufficient coloring was added to each mixture; water

was present in an amount to make 100%. The pH was adjusted to 5.5–7.0. The mixtures were autoclaved at 10 pounds per sq. inch gauge pressure for 70 minutes.

Table II

Ex. No.	Additive	Percent Amount	Flavor
1	None		Soy protein-Low intens.
2	Diethylacetal of mercapto-acetaldehyde.	0.005	Weakly meat-like.
3	do	0.03	Meat-like.
4	Diethylacetal of mercapto-acetaldehyde and Xylose	0.01 0.07	Meat-like (slightly browned).
5	2,5-dihydroxy-1,4-dithiane	0.009	Weakly meat-like.
6	do	0.02	Meat-like.
7	2,5-dihydroxy-1,4-dithiane and Xylose	0.01 0.015	Do.
8	2,5-dihydroxy-1,4-dithiane and Xylose	0.01 0.07	Meat-like (browned).
9	Hemimercaptal of Xylose and Mercaptoacetaldehyde.	0.03	Meat-like.
10	do	0.06	Do.
11	do	0.075	Strong meat-like.
12	do	0.15	Do.

The term "browned" means that the product had a caramelized, seared, burnt taste.

EXAMPLE 13

To tomato sauce was added the flavoring material of Example 7. These agents imparted an agreeable meat-like flavor to the sauce.

EXAMPLE 14

The flavoring material of Example 7 was added to green peas, which were then canned and sterilized. This provided a desirable meat-like flavor to the vegetable.

The products of Examples 2–8, were also aged at 70° F. for 90 days. After this aging period, the products which did not contain xylose had lost some of their meat-like flavor and aroma, but the flavor characteristics of those to which xylose had been added were more meat-like.

As stated above, the object of this invention is to produce a basic meat flavor to which can be added other spices, etc. to produce specific effects. For example, a ham flavor can be produced by adding to the product of Example 4 a mixture containing sodium glutamate, casein hydrolyzate, salt, pepper, clove, mustard, and smoke. When a chicken flavor is desired, a flavor mixture containing sodium glutamate, casein hydrolyzate, salt, celery, and onion can be added to any of the products of Examples 4–12.

What is claimed is:

1. A process for imparting a meat-like flavor to an edible composition, said process comprising mixing with the composition from about 0.005 to about 0.06% by weight of a flavoring agent which is a derivative of mercapto-acetaldehyde in which the mercapto-acetaldehyde is linked by an acetal type linkage to a compound selected from the group consisting of alcohols, mercaptans and aldehydes having from 1 to 5 carbon atoms.

2. An edible composition having a meat-like flavor and comprising from about 0.005 to about 0.06% by weight of a flavoring agent which is a derivative of mercapto-acetaldehyde in which the mercapto-acetaldehyde is linked by an acetal type linkage to a compound selected from the group consisting of alcohols, mercaptans and aldehydes having from 1 to 5 carbon atoms.

3. An edible composition having a meat-like flavor and comprising from about 0.015 to about 0.07% of xylose and from about 0.005 to about 0.06% by weight of a flavoring agent which is a derivative of mercapto-acetaldehyde in which the mercapto-acetaldehyde is linked by an acetal type linkage to a compound selected from the group consisting of alcohols, mercaptans and aldehydes having from 1 to 5 carbon atoms.

4. An edible composition having a meat-like flavor and comprising from about 0.01 to about 0.06% by weight of 2,5-dihydroxy-1,4-dithiane.

5. An edible composition having a meat-like flavor and comprising from about 0.01 to about 0.06% by weight of the diethyl acetal of mercapto-acetaldehyde.

6. An edible composition having a meat-like flavor and comprising from about 0.01 to about 0.06% by weight of the hemi-mercaptal of mercapto-acetaldehyde.

7. An edible composition having a meat-like flavor and comprising from about 0.01 to about 0.06% by weight of the dithioacetal formed by xylose and mercapto-acetaldehyde.

References Cited in the file of this patent

UNITED STATES PATENTS

2,560,531 Kipnis et al. ---------- July 17, 1951
2,594,379 Barch ---------- Apr. 29, 1952

Maltol digest

United States Patent Office

3,015,654

Patented Jan. 2, 1962

3,015,654

PREPARATION OF O-GALACTOSYLISOMALTOL

John E. Hodge and Earl C. Nelson, Peoria, Ill., assignors to the United States of America as represented by the Secretary of Agriculture

No Drawing. Filed Dec. 10, 1959, Ser. No. 858,837

6 Claims. (Cl. 260—210)

(Granted under Title 35, U.S. Code (1952), sec. 266)

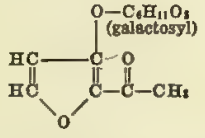
This invention pertains to a method for preparing the known compound, isomaltol (Backe: Comptes Rendus 150: 540–543 (1910) and ibid 151: 78–80 (1910)).

This invention further relates to the preparation of a new compound, O-galactosylisomaltol.

Maltol, discovered by Brand in roasted malt, is commercially available. It has a marked caramel-butterscotch aroma and flavor and accordingly is employed in confectionary products, pastries and related bakery products, fruit flavors, and in other foodstuffs where a caramel-like and fruity flavor is desired.

Isomaltol was discovered by Backe, supra, who obtained it in micro quantities by acidic extractive distillation of breads made of wheat flour. It possesses a caramel-like, somewhat fruity flavor very similar to that of maltol. However, it melts at 102° C. rather than at 162° C. and is considerably more volatile than maltol. Accordingly, it would be preferred for many applications if it became available at a comparable price.

Our novel compound, O-galactosylisomaltol, is an O-glycoside in which D-galactose is linked to the isomaltol aglycone through the strongly acidic enolic hydroxyl group of the latter. We believe that O-galactosylisomaltol has the following structure:



Our new method or process for the preparation of isomaltol in favorable yields involves the discovery that we can synthesize the novel intermediate compound O-galactosylisomaltol, which readily hydrolyzes in the presence of acid or alkali or under the influence of heat and moisture to liberate isomaltol and galactose. It is obvious that it would not be necessary to split the O-galactosylisomaltol and isolate the isomaltol for flavor use in pastries, baked goods, boiled candies, etc. (and especially those containing a hydrolysis-promoting acid such as citric or tartaric) since the galactoside is hydrolyzed to the flavorful isomaltol and the harmless galactose by the heat and steam present during the cooking or baking process.

Our invention comprises the discovery that we can synthesize our novel intermediate, namely O-galactosylisomaltol by reacting milk sugar, such as α-lactose hydrate, or other source of lactose, with the salt of a strongly basic secondary amine ($K_B > 10^{-8}$ in water) such as piperidine acetate, piperidine dihydrogen phosphate, morpholine acetate, dimethylamine acetate, diethylamine formate, or diethanolamine phosphate in an inert solvent medium such as methanol, ethanol, isopropanol, or dimethylformamide, and in the further presence of a non-reactant tertiary amine buffer such as trimethylamine, triethylamine, triethanolamine, N-methylmorpholine, pyridine, and mixed pyridine bases (isomeric picolines) or a sterically hindered non-reactant secondary amine such as di-isopropylamine, dicyclohexylamine, and 2,6-dimethylpiperidine at a reaction temperature in the range 60 to 100° C. for from 10 to 24 hours. At the end of the reaction period O-galactosylisomaltol is crystallized and recovered from the reaction mixture by filtration.

Isolation of the O-galactosylisomaltol would not be necessary in a commercial process for preparing isomaltol. As is shown by the examples, the reaction mixture can be acidified and then steam distilled or acidified, heated, and solvent-extracted with benzene, chlorinated hydrocarbons, ethers, esters, ketones, hydrocarbons, or higher alcohols to obtain the isomaltol by evaporation of the solvent.

The amine salt reactant of our invention is basic, neutral, or weakly acidic; it is not strongly acidic. Because it can be recovered from the reaction mixture unchanged, it acts in a catalytic manner and therefore the amount used is not critical. However, we prefer to use from one-half to two moles of amine salt for each mole of lactose in the reaction mixture to obtain reasonable reaction times in the temperature range of 60 to 100° C. We need not add amine salt as such to the reaction mixture; ordinarily we add the basic secondary amine and the salt-forming acid separately in the desired ratio. Furthermore, because organic acids are generated as byproducts in the reaction mixture as the desired reaction proceeds, it is not necessary to add a full mole of the salt-forming acid for each mole of secondary amine reactant.

The inert solvent is not necessary for the synthesis of O-galactosylisomaltol. We have conducted the reaction in non-reactant tertiary amine media without the addition of further solvent. However, use of an alcoholic solvent allows cleaner and easier separation of O-galactosylisomaltol from byproducts in the reaction mixture and allows the selection and fixing of a nearly constant reaction temperature by boiling and refluxing the properly selected solvent.

The presence of non-reactant tertiary amine or non-reactant sterically hindered secondary amine is not necessary for the synthesis of O-galactosylisomaltol. We have conducted the synthesis successfully in alcoholic media and in dimethylformamide without the use of non-reactant amine buffer. However, when it is desired to recover O-galactosylisomaltol, we prefer to add to the reaction mixture an amount of tertiary amine or non-reactant secondary amine that will keep the reaction mixture weakly basic throughout the heating period to thereby prevent hydrolysis and loss of O-galactosylisomaltol. When it is desired to recover isomaltol from the reaction mixture, for example, by acidification and steam distillation, the amine buffer need not be used.

An O-glucosylisomaltol was not found using maltose hydrate in place of α-lactose hydrate under the conditions outlined in the examples, but it is apparent that β-lactose hydrate, anhydrous β-lactose, anhydrous α-lactose, and other sources of lactose such as dried whey and dried skim milk would be operative.

The following examples are presented to further teach the practice of our invention.

Example 1

In a 2-liter, 3-necked reaction flask, fitted with a motor-driven anchor-bladed stirrer, thermometer, and reflux condenser, 360 g. (1 mole) of α-lactose hydrate, 85 g. (1 mole) of piperidine, 60 g. (1 mole) of glacial acetic acid, 100 ml. of triethylamine, and 300 ml. of absolute ethanol were heated and stirred at a constant temperature of 75° C. The last of the solids dissolved between 10 and 12 hours of heating. After 15 hours of heating the reaction product was present and was isolated in 28 percent of the theoretical yield in a separate experiment.

After 24 hours of heating at 75° C., 300 ml. of absolute ethanol was added; then the dark brown reaction mixture was continually stirerd for one hour while the flask was cooled in an ice-water bath to crystallize the product. The precipitate was filtered off with suction, washed several times with ethanol unitil nearly white, and dried in a vacuum desiccator over anhydrous calcium chloride to a constant weight of 106 g. (37 percent of theory); melting point, 204–205° C. Recrystallization from hot water or aqueous alcohol with the use of decolorizing charcoal gave pure whie crystals of the same melting point, and with a specific optical rotation of —4.5° for a 2 percent solution in water with sodium light. Analyses gave 50.18 percent carbon, 5.65 percent hydrogen. Calculated for $C_{12}H_{16}O_8$: 50.00 percent carbon, 5.60 percent hydrogen.

Acid hydrolysis or acid hydrogenolysis of the neutral compound, $C_{12}H_{16}O_8$, gave crystalline α-D-galactose, $C_6H_{12}O_6$, M.P. 165–167°, identified by its optical rotation in water and by its conversion by nitric acid to crystalline mucic acid, M.P. 213–214°. Methanolysis in anhydrous methanol-hydrogen chloride gave the known methyl β-D-galactopyranoside, $C_7H_{14}O_6$, M.P. 177–178°, no optical rotation in water; found: 43.30 percent carbon, 7.33 percent hydrogen. Calculated for $C_7H_{14}O_6$: 43.30 percent carbon, 7.28 percent hydrogen.

When the acid hydrolysate of the neutral compound, $C_{12}H_{16}O_8$, was extracted with ether and the ether extracts concentrated by evaporation, a colorless acidic compound was crystallized. Recrystallized and sublimed, the acidic compound melted at 100–101° C. By titration with standard base, the neutral equivalent was 124. Found: 57.18 percent carbon, 4.80 percent hydrogen. Calculated for $C_6H_6O_3$: 126.1 molecular weight, 57.14 percent carbon, 4.80 percent hydrogen. This same compound was sublimed and distilled from the neutral $C_{12}H_{16}O_8$ compound when it was heated to 205° and caramelized. It was identified as "isomaltol," by converting it to the O-methyl ether (M.P. 101–103°), the O-benzoyl ester (M.P. 100–101°), and the same green copper salt reported in the literature. Moreover, the stable violet color with ferric chloride, the acidity, the volatility, the solubilities, and the reducing action toward Fehling solution conformed exactly to the literature reports.

Example 2

In the same apparatus described in Example 1, precooled to 1° C., the following were added in the order given; 500 ml. absolute methanol, 48 g. (1.06 moles) of anhydrous dimethylamine, 100 g. trimethylamine, 360 g. (1.00 mole) of α-lactose hydrate, and 60 g. (1.00 mole) of glacial acetic acid was slowly dropped in with stirring. The mixture was then continually stirred and heated under reflux at its boiling point for 24 hours. The temperature increased from 60° (1 hour) to 67° (2 hours) to 68° (10 hours) to 71° (20 hours) and to 72° C. at 24 hours. The reaction flask was cooled to 2° C. and held at this temperature for one hour until crystallization of the product was essentially complete. Isolated as described in Example 1, this first crop weighed 60.5 g.

The filtrate and washings were reheated at a constant reflux temperature of 77±1° C. for 8 hours. After removing the solvents by distillation at atmospheric pressure over 2 additional hours, the dark solution was again cooled to 1° C. and a second crop, isolated in the same way as the first, weighed 3 g.

Both crops were identical, M.P. 204–205°, representing the same compound, $C_{12}H_{16}O_8$, as was obtained in Example 1. The total yield in this experiment was 63.5 g., 22 percent of the theoretical amount.

Example 3

The reaction described in Example 1 was repeated with 87 g. of morpholine (1 mole) in place of 85 g. of

piperidine, except that the reaction mixture was refluxed at its natural boiling point of 82° C. for 24 hours. The same compound, O-galactosylisomaltol, $C_{12}H_{16}O_8$, was isolated, 59.2 g. (21 percent of theory). The filtrate from the reaction mixture was reheated at the boiling point, 82–83°, for 24 hours longer to produce 15.4 g. additional O-galactosylisomaltol. Total yield, 74.6 g. (26 percent of theory).

Example 4

Thirteen grams of crude O-galactosylisomaltol,

$C_{12}H_{16}O_8$

was suspended in 100 ml. of water and 100 ml. of 4-molar orthophosphoric acid was added. The 2-molar acidic solution was steam-distilled until 900 ml. of aqueous distillate was collected, and a violet color was no longer obtained from drops of the distillate upon addition of ferric chloride. The distillate was extracted three times with 200 ml. portions of chloroform. The chloroform layers were separated, combined, dried over anhydrous sodium sulfate, and then distilled at atmospheric pressure. The crystalline residue in the distilling flask was washed out with cold water and dried in air to a constant weight of 2.3 g. (40 percent of the theoretical amount of isomaltol from 13 g. of O-galactosylisomaltol). When purified by recrystallization from benzene, the compound was identical in all properties with the isomaltol isolated by ether extraction of an acid hydrolyzate of O-galactosylisomaltol (Example 1).

Example 5

Forty grams of O-galactosylisomaltol, $C_{12}H_{16}O_8$, was placed in a 250 ml. alembic flask which was then lowered into a Wood's metal bath preheated to 230° C. Distillation began with liquefaction and caramelization of the O-galactosylisomaltol within 3 minutes and continued at atmospheric pressure for 10 minutes as the bath temperature was held in the range 245–260° C. The liquid distillate of strong, fragrant aromatic odor, immediately crystallized in the receiver. Yield, 14 g. The crystalline distillate was broken up under water at room temperature and cooled to 1° C. before filtering and re-washing with ice-water. After drying over anhydrous calcium chloride at atmospheric pressure, the yield of pure compound was 12 g. (68 percent of theory); M.P. 101–102°, unchanged upon recrystallization from water or ether. This compound was identical with isomaltol obtained in Example 1.

Example 6

Anhydrous dimethylamine, 23 g. (0.5 mole), was dissolved in 300 ml. of dimethylformamide, and 180 g. (0.5 mole) of α-lactose hydrate was added. While cooling the mixture at 0° C., 30 g. (0.5 mole) of glacial acetic acid was slowly added; then the mixture was heated at 90° C. under reflux for 12 hours. After concentration of the dark solution under vacuum at 90°, 18–20 mm. mercury pressure, for 3 hours to remove most of the solvent, the warm sirupy residue was diluted with 300 ml. of hot, absolute ethanol. A small amount of insoluble, dark, melanoidin-like substance was filtered off. The filtrate, upon cooling and seeding, gave 14 g.; and, after vacuum concentration of the second filtrate, 12 g. more of O-galactosylisomaltol, M.P. 204–5°. The total yield is 18 percent of the theoretical amount.

Example 7

Nine grams of O-galactosylisomaltol, dissolved in 800 ml. of 1.5 percent sodium carbonate solution, was heated at 85–90° C. for 30 minutes. The red solution was then allowed to stand at 25° C. for two days before it was acidified with 100 ml. of 4-molar orthophosphoric acid and extracted twice with 250 ml. portions of ether. The combined ether extracts were dried over anhydrous sodium sulfate and distilled to yield 1 g. of crystalline isomaltol (25 percent of theory); M.P. 99–101°.

Example 8

A pie crust dough consisting of 62.5 gm. flour, 36 gm. hydrogenated vegetable oil shortening, 15 ml. cold water, and 0.3125 gm. O-galactosylisomaltol (0.5 percent based on the weight of the flour) was rolled to a thickness of ⅛ inch and baked for 8 minutes at 500° F. A taste panel preferred this pie crust over one identically prepared except that it did not contain O-galactosylisomaltol.

We claim:

1. A method comprising heating a reaction mixture containing a source of lactose, a salt of a strongly basic secondary amine ($K_B > 10^{-8}$ in water), and a non-reactant member selected from the group consisting of an inert solvent, a tertiary amine buffer, a sterically hindered secondary amine, a mixture of said inert solvent and said tertiary amine buffer, and a mixture of said inert solvent and said sterically hindered secondary amine, at a temperature of about from 60° to 100° C. for about from 10 to 24 hours and recovering O-galactosylisomaltol.

2. A method comprising heating a reaction mixture containing a source of lactose, a salt selected from the group consisting of piperidine acetate, piperidine dihydrogen phosphate, morpholine acetate, dimethylamine acetate, diethylamine formate, and diethanolamine phosphate, and a non-reactant member selected from the group consisting of an inert solvent, a tertiary amine buffer, a sterically hindered secondary amine, a mixture of said inert solvent and said tertiary amine buffer, and a mixture of said inert solvent and said sterically hindered secondary amine, at a temperature of about from 60° to 100° C. for about from 10 to 24 hours and recovering O-galactosylisomaltol.

3. A method comprising heating a reaction mixture containing a source of lactose, a strongly basic secondary amine ($K_B > 10^{-8}$ in water), a weak acid, and a non-reactant member selected from the group consisting of an inert solvent, a tertiary amine buffer, a sterically hindered secondary amine, a mixture of said inert solvent and said

tertiary amine buffer, and a mixture of said inert solvent and said sterically hindered secondary amine, at a temperature of about from 60° to 100° C. for about from 10 to 24 hours and recovering O-galactosylisomaltol.

4. A method comprising heating a reaction mixture containing a source of lactose, a secondary amine selected from the group consisting of piperidine, morpholine, dimethylamine, diethylamine, and diethanolamine, an acid selected from the group consisting of formic acid, acetic acid, and phosphoric acid, and a non-reactant member selected from the group consisting of an inert solvent, a tertiary amine buffer, a sterically hindered secondary amine, a mixture of said inert solvent and said tertiary amine buffer, and a mixture of said inert solvent and said sterically hindered secondary amine, at a temperature of about from 60° to 100° C. for about from 10 to 24 hours and recovering O-galactosylisomaltol.

5. The method comprising the steps of refluxing a reaction mixture comprising a source of lactose, a secondary amine selected from the group consisting of piperidine, morpholine, dimethylamine, diethylamine, and diethanolamine, an acid selected from the group consisting of formic acid, acetic acid and phosphoric acid, an inert solvent and a tertiary amine buffer at about 75° C. for at least about 15 hours and recovering O-galactosylisomaltol.

6. The method of recovering pure isomaltol comprising the steps of hydrolyzing the crude reaction product of claim 2 with acid, extracting the isomaltol with an organic solvent, and removing the solvent.

References Cited in the file of this patent

UNITED STATES PATENTS

2,305,621 Kremers ..... Dec. 22, 1942

OTHER REFERENCES

Backe: Comptes Rendus 150 (1910), pages 540–3 and 151 (1910), pages 78–80. Copy in Sci. Lib.

Maltol digest

United States Patent Office 3,054,805 Patented Sept. 18, 1962

3,054,805

PROCESS FOR PREPARING ISOMALTOL

John E. Hodge and Earl C. Nelson, Peoria, Ill., assignors to the United States of America as represented by the Secretary of Agriculture

No Drawing. Original application Dec. 10, 1959, Ser. No. 858,837, now Patent No. 3,015,654, dated Jan. 2, 1962. Divided and this application Aug. 16, 1961, Ser. No. 131,940

2 Claims. (Cl. 260—345.9)

(Granted under Title 35, U.S. Code (1952), sec. 266)

This is a division of applicants' copending application, S.N. 858,837, filed December 10, 1959, now Patent No. 3,015,654.

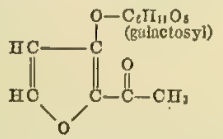
This invention pertains to a method for preparing the known compound, isomaltol (Backe: Comptes Rendus 150: 540–543 (1910) and ibid 151: 78–80 (1910)).

This invention further relates to the preparation of a new compound, O-galactosylisomaltol.

Maltol, discovered by Brand in roasted malt, is commercially available. It has a marked caramel-butterscotch aroma and flavor and accordingly is employed in confectionary products, pastries and related bakery products, fruit flavors, and in other foodstuffs where a caramel-like and fruity flavor is desired.

Isomaltol was discovered by Backe, supra, who obtained it in micro quantities by acidic extractive distillation of breads made of wheat flour. It possesses a caramel-like, somewhat fruity flavor very similar to that of maltol. However, it melts at 102° C. rather than at 162° C. and is considerably more volatile than maltol. Accordingly, it would be preferred for many applications if it became available at a comparable price.

Our novel compound, O-galactosylisomaltol, is an O-glycoside in which D-galactose is linked to the isomaltol aglycone through the strongly acidic enolic hydroxyl group of the latter. We believe that O-galactosylisomaltol has the following structure:



Our new method or process for the preparation of isomaltol in favorable yields involves the discovery that we can synthesize the novel intermediate compound O-galactosylisomaltol, which readily hydrolyzes in the presence of acid or alkali or under the influence of heat and moisture to liberate isomaltol and galactose. It is obvious that it would not be necessary to split the O-galactosylisomaltol and isolate the isomaltol for flavor use in pastries, baked goods, boiled candies, etc. (and especially those containing a hydrolysis-promoting acid such as citric or tartaric) since the galactoside is hydrolyzed to the flavorful isomaltol and the harmless galactose by the heat and steam present during the cooking or baking process.

Our invention comprises the discovery that we can synthesize our novel intermediate, namely O-galactosylisomaltol by reacting milk sugar, such as α-lactose hydrate or other source of lactose, with the salt of a strongly basic secondary amine ($K_B > 10^{-8}$ in water) such as piperidine acetate, piperidine dihydrogen phosphate, morpholine acetate, dimethylamine acetate, diethylamine formate,

or diethanolamine phosphate in an inert solvent medium such as methanol, ethanol, isopropanol, or dimethylformamide, and in the further presence of a non-reactant tertiary amine buffer such as trimethylamine, triethylamine, triethanolamine, N-methylmorpholine, pyridine, and mixed pyridine bases (isomeric picolines) or a sterically hindered non-reactant secondary amine such as di-isopropylamine, dicyclohexylamine, and 2,6-dimethylpiperidine at a reaction temperature in the range 60 to 100° C. for from 10 to 24 hours. At the end of the reaction period O-galactosylisomaltol is crystallized and recovered from the reaction mixture by filtration.

Isolation of the O-galactosylisomaltol would not be necessary in a commercial process for preparing isomaltol. As is shown by the examples, the reaction mixture can be acidified and then steam distilled or acidified, heated, and solvent-extracted with benzene, chlorinated hydrocarbons, ethers, esters, ketones, hydrocarbons, or higher alcohols to obtain the isomaltol by evaporation of the solvent.

The amine salt reactant of our invention is basic, neutral, or weakly acidic; it is not strongly acidic. Because it can be recovered from the reaction mixture unchanged, it acts in a catalytic manner and therefore the amount used is not critical. However, we prefer to use from one-half to two moles of amine salt for each mole of lactose in the reaction mixture to obtain reasonable reaction times in the temperature range of 60 to 100° C. We need not add amine salt as such to the reaction mixture; ordinarily we add the basic secondary amine and the salt-forming acid separately in the desired ratio. Furthermore, because organic acids are generated as byproducts in the reaction mixture as the desired reaction proceeds, it is not necessary to add a full mole of the salt-forming acid for each mole of secondary amine reactant.

The inert solvent is not necessary for the synthesis of O-galactosylisomaltol. We have conducted the reaction in non-reactant tertiary amine media without the addition of further solvent. However, use of an alcoholic solvent allows cleaner and easier separation of O-galactosylisomaltol from byproducts in the reaction mixture and allows the selection and fixing of a nearly constant reaction temperature by boiling and refluxing the properly selected solvent.

The presence of non-reactant tertiary amine or non-reactant sterically hindered secondary amine is not necessary for the synthesis of O-galactosylisomaltol. We have conducted the synthesis successfully in alcoholic media and in dimethylformamide without the use of non-reactant amine buffer. However, when it is desired to recover O-galactosylisomaltol, we prefer to add to the reaction mixture an amount of tertiary amine or non-reactant secondary amine that will keep the reaction mixture weakly basic throughout the heating period to thereby prevent hydrolysis and loss of O-galactosylisomaltol. When it is desired to recover isomaltol from the reaction mixture, for example, by acidification and steam distillation, the amine buffer need not be used.

An O-glucosylisomaltol was not found using maltose hydrate in place of α-lactose hydrate under the conditions outlined in the examples, but it is apparent that β-lactose hydrate, anhydrous β-lactose, anhydrous α-lactose, and other sources of lactose such as dried whey and dried skim milk would be operative.

The following examples are presented to further teach the practice of our invention.

Example 1

In a 2-liter, 3-necked reaction flask, fitted with a motor-driven anchor-bladed stirrer, thermometer, and reflux condenser, 360 g. (1 mole) of α-lactose hydrate, 85 g. (1 mole) of piperidine, 60 g. (1 mole) of glacial acetic acid,

100 ml. of triethylamine, and 300 ml. of absolute ethanol were heated and stirred at a constant temperature of 75° C. The last of the solids disolved between 10 and 12 hours of heating. After 15 hours of heating the reaction product was present and was isolated in 28 percent of the theoretical yield in a separate experiment. After 24 hours of heating at 75° C., 300 ml. of absolute ethanol was added; then the dark brown reaction mixture was continually stirred for one hour while the flask was cooled in an ice-water bath to crystallize the product. The precipitate was filtered off with suction, washed several times with ethanol until nearly white, and dried in a vacuum desiccator over anhydrous calcium chloride to a constant weight of 106 g. (37 percent of theory); melting point, 204–205° C. Recrystallization from hot water or aqueous alcohol with the use of decolorizing charcoal gave pure white crystals of the same melting point, and with a specific optical rotation of —4.5° for a 2 percent solution in water with sodium light. Analyses gave 50.18 percent carbon, 5.65 percent hydrogen. Calculated for $C_{12}H_{16}O_8$: 50.00 percent carbon, 5.60 percent hydrogen.

Acid hydrolysis or acid hydrogenolysis of the neutral compound, $C_{12}H_{16}O_8$, gave crystalline α-D-galactose, $C_6H_{12}O_6$, M.P. 165–167°, identified by its optical rotation in water and by its conversion by nitric acid to crystalline mucic acid, M.P. 213–214°. Methanolysis in anhydrous methanol-hydrogen chloride gave the known methyl β-D-galactopyranoside, $C_7H_{14}O_6$, M.P. 177–178°, no optical rotation in water; found: 43.30 percent carbon, 7.33 percent hydrogen. Calculated for $C_7H_{14}O_6$: 43.30 percent carbon, 7.28 percent hydrogen.

When the acid hydrolysate of the neutral compound, $C_{12}H_{16}O_8$ was extracted with ether and the ether extracts concentrated by evaporation, a colorless acidic compound was crystallized. Recrystallized and sublimed, the acidic compound melted at 100–101° C. By titration with standard base, the neutral equivalent was 124. Found: 57.18 percent carbon, 4.80 percent hydrogen. Calculated for $C_6H_6O_3$: 126.1 molecular weight, 57.14 percent carbon, 4.80 percent hydrogen. This same compound was sublimed and distilled from the neutral $C_{12}H_{16}O_8$ compound when it was heated to 205° and caramelized. It was identified as "isomaltol," by converting it to the O-methyl ether (M.P. 101–103°), the O-benzoyl ester (M.P. 100–101°), and the same green copper salt reported in the literature. Moreover, the stable violet color with ferric chloride, the acidity, the volatility, the solubilities, and the reducing action toward Febling solution conformed exactly to the literature reports.

Example 2

In the same apparatus described in Example 1, precooled to 1° C., the following were added in the order given: 500 ml. absolute methanol, 48 g. (1.06 moles) of anhydrous dimethylamine, 100 g. trimethylamine, 360 g. (1.00 mole) of α-lactose hydrate, and 60 g. (1.00 mole) of glacial acetic acid was slowly dropped in with stirring. The mixture was then continually stirred and heated under reflux at its boiling point for 24 hours. The temperature increased from 60° (1 hour) to 67° (2 hours) to 68° (10 hours) to 71° (20 hours) and to 72° C. at 24 hours. The reaction flask was cooled to 2° C. and held at this temperature for one hour until crystallization of the product was essentially complete. Isolated as described in Example 1, this first crop weighed 60.5 g.

The filtrate and washings were reheated at a constant reflux temperature of 77±1° C. for 8 hours. After removing the solvents by distillation at atmospheric pressure over 2 additional hours, the dark solution was again cooled to 1° C. and a second crop, isolated in the same way as the first, weighed 3 g.

Both crops were identical, M.P. 204–205°, representing the same compound, $C_{12}H_{16}O_8$, as was obtained in Example 1. The total yield in this experiment was 63.5 g., 22 percent of the theoretical amount.

Example 3

The reaction described in Example 1 was repeated with 87 g. of morpholine (1 mole) in place of 85 g. of piperidine, except that the reaction mixture was refluxed at its natural boiling point of 82° C. for 24 hours. The same compound, O-galactosylisomaltol, $C_{12}H_{16}O_8$, was isolated, 59.2 g. (21 percent of theory). The filtrate from the reaction mixture was reheated at the boiling point, 82–83°, for 24 hours longer to produce 15.4 g. additional O-galactosylisomaltol. Total yield, 74.6 g. (26 percent of theory).

Example 4

Thirteen grams of crude O-galactosylisomaltol,

$C_{12}H_{16}O_8$

was suspended in 100 ml. of water and 100 ml. of 4-molar orthophosphoric acid was added. The 2-molar acidic solution was steam-distilled until 900 ml. of aqueous distillate was collected, and a violet color was no longer obtained from drops of the distillate upon addition of ferric chloride. The distillate was extracted three times with 200 ml. portions of chloroform. The chloroform layers were separated, combined, dried over anhydrous sodium sulfate, and then distilled at atmospheric pressure. The crystalline residue in the distilling flask was washed out with cold water and dried in air to a constant weight of 2.3 g. (40 percent of the theoretical amount of isomaltol from 13 g. of O-galactosylisomaltol). When purified by recrystallization from benzene, the compound was identical in all properties with the isomaltol isolated by ether extraction of an acid hydrolysate of O-galactosylisomaltol (Example 1).

Example 5

Forty grams of O-galactosylisomaltol, $C_{12}H_{16}O_8$, was placed in a 250 ml. alembic flask which was then lowered into a Woods metal bath preheated to 230° C. Distillation began with liquefaction and caramelization of the O-galactosylisomaltol within 3 minutes and continued at atmospheric pressure for 10 minutes as the bath temperature was held in the range 245–260° C. The liquid distillate of strong, fragrant aromatic odor, immediately crystallized in the receiver. Yield, 14 g. The crystalline distillate was broken up under water at room temperature and cooled to 1° C. before filtering and re-washing with ice-water. After drying over anhydrous calcium chloride at atmospheric pressure, the yield of pure compound was 12 g. (68 percent of theory); M.P. 101–102°, unchanged upon recrystallization from water or ether. This compound was identical with isomaltol obtained in Example 1.

Example 6

Anhydrous dimethylamine, 23 g. (0.5 mole), was dissolved in 300 ml. of dimethylformamide, and 180 g. (0.5 mole) of α-lactose hydrate was added. While cooling the mixture at 0° C., 30 g. (0.5 mole) of glacial acetic acid was slowly added; then the mixture was heated at 90° C. under reflux for 12 hours. After concentration of the dark solution under vacuum at 90°, 18–20 mm. mercury pressure, for 3 hours to remove most of the solvent, the warm sirupy residue was diluted with 300 ml. of hot, absolute ethanol. A small amount of insoluble, dark, melanoidin-like substance was filtered off. The filtrate, upon cooling and seeding, gave 14 g.; and, after vacuum concentration of the second filtrate, 12 g. more of O-galactosylisomaltol, M.P. 204–5°. The total yield is 18 percent of the theoretical amount.

Example 7

Nine grams of O-galacetosylisomaltol, dissolved in 800 ml. of 1.5 percent sodium carbonate solution, was heated at 85–90° C. for 30 minutes. The red solution was then allowed to stand at 25° C. for two days before it was acidified with 100 ml. of 4-molar orthophosphoric acid and extracted twice with 250 ml. portions of ether. The

combined ether extracts were dried over anhydrous sodium sulfate and distilled to yield 1 g. of crystalline isomaltol (25 percent of theory); M.P. 99–101°.

Example 8

A pie crust dough consisting of 62.5 gm. flour, 36 gm. hydrogenated vegetable oil shortening, 15 ml. cold water, and 0.3125 gm. O-galactosylisomaltol (0.5 percent based on the weight of the flour) was rolled to a thickness of ⅛ inch and baked for 8 minutes at 500° F. A taste panel preferred this pie crust over one identically prepared except that it did not contain O-galactosylisomaltol.

Having disclosed our invention, we claim:

1. The method of recovering pure isomaltol comprising pyrolyzing O-galactosylisomaltol at a temperature of about from 245–260° C. in the absence of added moisture to liberate isomaltol, and recovering the isomaltol.

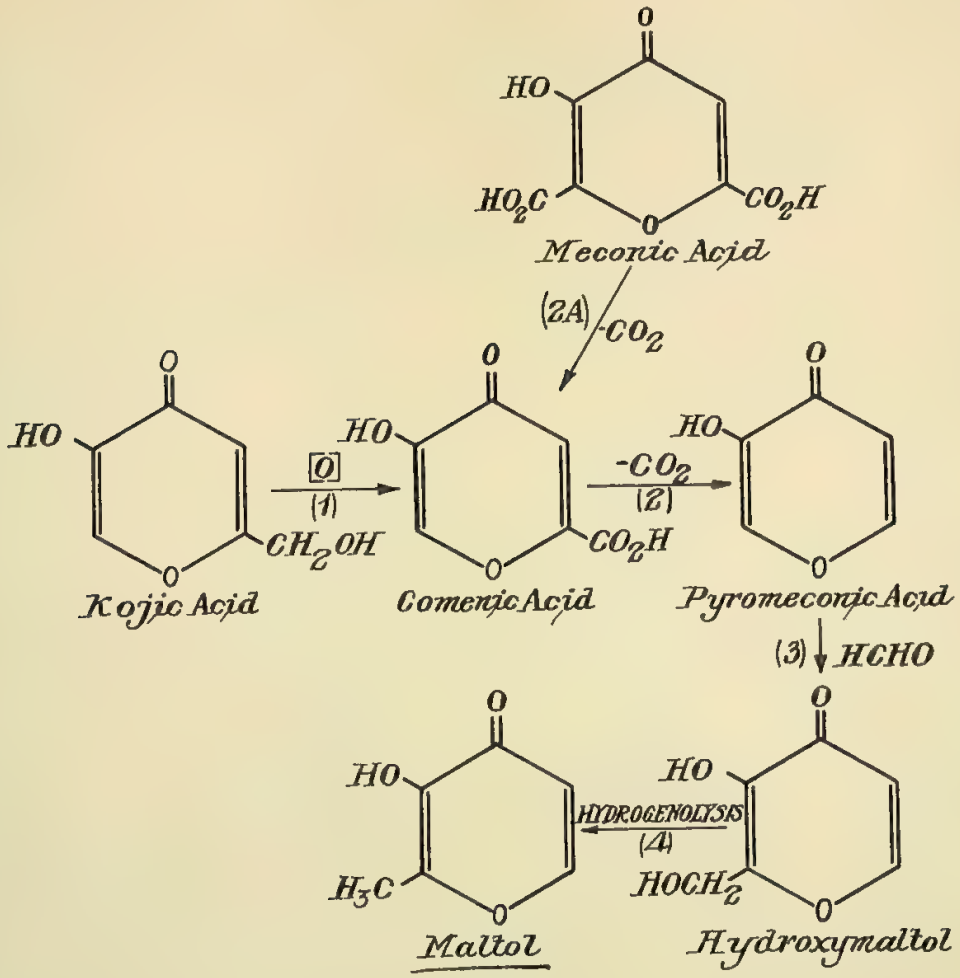
2. The method of recovering pure isomaltol comprising subjecting O-galactosylisomaltol to alkali hydrolysis to liberate isomaltol, extracting the isomaltol with an organic solvent, and recovering pure isomaltol from the resulting extract.

No references cited.

April 21, 1964 B. E. TATE ETAL 3,130,204

PREPARATION OF GAMMA-PYRONES

Filed Feb. 7, 1962



INVENTORS

Bryce E. Tate

Robert L. Miller

BY Connolly and Hutz

ATTORNEYS

United States Patent Office 3,130,204
Patented Apr. 21, 1964

3,130,204

PREPARATION OF GAMMA-PYRONES

Bryce E. Tate, Niantic, Conn., and Robert L. Miller, Brooklyn, N.Y., assignors to Chas. Pfizer & Co., Inc., New York, N.Y., a corporation of Delaware

Filed Feb. 7, 1962, Ser. No. 171,732
15 Claims. (Cl. 260—345.9)

The present invention relates to the preparation of gamma-pyrone compounds and particularly relates to a process for the preparation of an especially valuable gamma-pyrone, maltol.

It is well known that maltol, 3-hydroxy-2-methyl-gamma-pyrone, is one of the most valuable gamma-pyrones. Its utility derives from the fact that maltol enhances the flavor and aroma of a variety of food products, thereby making them even more acceptable to the consumer. Among the foods which are markedly improved in these respects by maltol may be mentioned baked products such as breads, cakes and pies; confections such as candies and ice-creams and certain beverages such as coffee. In addition, maltol is used as an ingredient in perfumes and essences.

Heretofore, maltol has been obtained in limited quantity from natural products by difficult and expensive extraction processes. The commercial production of maltol has depended, for example, upon the destructive distillation of wood and, as is well known, these pyrolysis reactions generally provide low yields of the desired product. Furthermore, isolation processes have a tendency to be limited in capacity to the total supply of raw material readily available. In addition, there is a tendency for maltol obtained from such destructive-distillation processes to contain certain impurities which adversely affect its use as an aroma enhancer.

It has now been found possible to effect by the process of this invention the chemical synthesis of maltol from kojic acid, 2-hydroxy-methyl-5-hydroxy-gamma-pyrone, a substance which is readily available in large supply from economical fermentation processes. Furthermore, the maltol prepared by the process of this invention has been found to be free of contamination by impurities ordinarily found in maltol prepared by the aforementioned prior art destructive distillation processes.

It is accordingly a principal object of the present invention to provide a means to prepare maltol.

A more specific object is to prepare maltol from a freely available, economical starting material, kojic acid.

A further object of the invention is to provide maltol in a form particularly free of contaminants which adversely affect its utility as a flavor and aroma enhancer.

An additional object of the invention is to produce valuable gamma-pyrone intermediates such as pyromeconic acid and hydroxymaltol from kojic acid.

Other objects will be apparent to those skilled in the art from the following description.

The drawing is a flow sheet illustrating the reactions involved in the present invention.

The process of the present invention comprises (1) treating kojic acid with oxygen in the presence of a noble metal catalyst at a pH of at least about 10 to form comenic acid, (2) decarboxylating said comenic acid to form pyromeconic acid, (3) treating the pyromeconic acid with formaldehyde at a pH of at least about 5 to form hydroxymaltol and (4) reducing the hydroxymaltol under acidic to substantially neutral conditions to form maltol.

As will be exemplified hereinafter, this process of this invention results in a yield of maltol of about 50 percent based on kojic acid. In comparison with other routes using piperidinomethylpyromeconic acid or chloromaltol as intermediates and which yield maltol in respective yields of 1.6 percent and 5.5 percent, the process of the present invention is the first commercially feasible synthesis of maltol from kojic acid.

With respect to the first step (1) in the process of this invention, it is known from the prior art that when it is attempted to prepare comenic acid by treatment of kojic acid with oxygen in the presence of catalysts or with other oxidizing agents such as nitric acid or potassium permanganate, only traces of comenic acid are formed. Since kojic acid cannot usually be recovered from these reaction mixtures, the results are believed to be due to extensive destruction of the pyrone ring during said treatments. Furthermore, as is stated by Heyns in volume 87, Chemisches Berichte, page 14, 1954, the use of alkaline conditions during the catalytic oxidation of kojic acid with oxygen and in the presence of a catalyst would not be possible because of rapid destruction of the pyrone ring and, in fact, only traces of comenic acid could be obtained even at pH 7.4. It was therefore not to be expected that when kojic acid was treated with oxygen in the presence of a noble metal catalyst in solution at a pH of above 10, no destruction of the gamma pyrone ring occurred, but instead the 2-hydroxymethyl group was cleanly oxidized to the corresponding 2-carboxylate in nearly quantitative yields. Prior to the improved process of the present application, the only known synthesis of comenic acid from kojic acid in commercially feasible yield involved conversion of kojic acid to the corresponding 5-methyl ether derivative, oxidation of said ether to the corresponding methyl ether derivative of comenic acid and demethylation of said derivative to comenic acid. The overall yield of comenic acid from kojic acid by such an indirect process was of the order of only 25 percent.

It is a critical embodiment of step (1) of the present invention that the oxidation be carried out in an alkaline medium at pH 10 or above. It has been found that attempts to practice this step at lower pH's, for example, at pH 9 and at pH 7, have given results substantially in accord with prior art, that is, only trace amounts of comenic acid are obtained. On the other hand, the invention is broadly operable at pH's above 10, in fact, it is operable above the upper limit of measurable pH which is 14. For best yields and a particularly desirable rate of oxygen uptake it is preferred to practice step (1) of the instant invention at pH's of between about 11 and about 13.

The method of maintaining said minimum pH has not been found to be critical. Thus, it is feasible to adjust the pH to the minimum value at the onset of oxygenation and to add base during the reaction either incrementally or continuously or, alternatively, enough base may be added initially and all at once so that the final pH of the mixture does not fall below said minimum.

The means for maintaining the minimum pH contemplated herein is not critical to step (1) of the invention. Any strongly alkaline reagent capable of dissolving in the reaction mixture and which is inert with respect to oxygen, to the catalyst and to other intermediates may be used. For example, alkali metal hydroxides such as lithium hydroxide, sodium hydroxide, potassium hydroxide, and the like can be used as well as alkali metal carbonates such as sodium carbonate and potassium carbonate. Alkaline earth hydroxides such as calcium hydroxide, and the like may be used but are not preferred because of their low solubility in water and a tendency to form chelates with the intermediates. Strong organic nitrogen bases are not preferred because of a marked tendency to poison the catalyst. Particularly preferred because of its ready availability and low cost is sodium hydroxide; this may be added either in its solid form or as a solution in water.

The type or amount of noble metal catalyst employed in step (1) of the instant invention is not critical to its

application. Thus, it is possible to employ, for example, platinum and palladium, and the like, either in finely divided states (the so-called "blacks") or in such readily obtainable forms as oxides, or to employ noble metals supported on such solids as, for example, carbon and charcoal. The amount of catalyst employed can vary over a broad range, for example, 0.01, 0.1, 0.8, 1.0, 1.25, and 5 percent by weight of catalyst (calculated as metal) based on kojic acid have been used. It has been particularly convenient to employ about 1.0 percent of palladium based on the kojic acid used and to use said catalyst in the form of a commercially-available 5 percent palladium on carbon catalyst.

The oxygen used in step (1) of the process may be in the form of pure oxygen gas or it may be admixed with other gases. It is equally feasible to use pure oxygen or to use air (which contains about 23 percent of oxygen by weight) or to use mixtures of the two or to use other gas mixture containing oxygen so long as such other gases are inert with respect to the reaction intermediates and, in particular, do not poison the catalyst. It is especially convenient to employ oxygen-rich gas mixtures available as by-products from chemical manufacturing operations.

The reaction time and temperature for step (1) may be varied over a substantial range during practice of the instant invention. However, it is desirable to conduct the reaction at a temperature range from about 5 degrees to about 60 degrees C. and it is particularly preferred to carry out the reaction at temperatures below about 40 degrees C. It has been found that there tends to be a slight adverse effect on the yield and color of the products if temperatures of about 40 degrees C. are exceeded. The time of the reactions is found to depend primarily on the temperature at which it is carried out. In addition, the amount of catalyst used and the rate of introduction of oxygen influence the time required for complete consumption of the kojic acid. In general, times of about 4 through about 72 hours will be sufficient; the longer times usually are required at lower temperatures, at lower catalyst concentrations and at lower oxygen flow rates. In the direct preparation of comenic acid according to this invention, if the reaction is carried out at from about 20 degrees to about 40 degrees C. in the presence of about 1.0 percent catalyst based on kojic acid at a minimum pH of about 11 and at a flow rate equivalent to about 1400 ml./minute of oxygen per mol of kojic acid, said kojic acid has been substantially completely consumed at the end of about ten hours.

While it has been disclosed that the process is carried out with water employed as the solvent, it is to be understood that other inert solvents commonly employed in oxidation reactions can be used as minor components in admixture with water. It is preferred, however, to carry out step (1) of the reaction with water as the sole solvent rather than in mixtures to avoid difficulties sometimes found in obtaining precise and reliable measurements of pH.

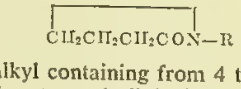
The purity of the kojic acid is not particularly critical to the practice of the present invention. However, it is found that crude kojic acid of purity below about 60 percent by weight often contains in admixture with it certain substances which are known to poison the catalyst. While the effects of these catalyst poisons can be partially overcome as by use of increased amounts of catalyst, it is found to be preferable to use kojic acid with a purity of about 60 percent and above.

Isolation of the comenic acid is conveniently accomplished by acidification of the reaction mixture. Thus, after filtration to remove the catalyst, sufficient strong acid is added to bring the pH to below at least 2.5. Suitable acids for this purpose are hydrochloric, sulfuric, nitric, and the like. However, it is preferred to adjust the pH to below about 1 to insure against possible coprecipitation of alkali-metal derivatives of the product such as may occur at higher pH's. The comenic acid can be removed by filtration or by centrifugation and can be dried in the air or by other standard means.

With respect to the second step (2) of the process of this invention, it is known that comenic acid may be decarboxylated to form pyromeconic acid. However, as is indicated by the conditions used by previous investigators, the feasible commercial production of pyromeconic acid from comenic acid would be expected to be difficult and expensive. Thus, Garkusha in volume 16, Journal of General Chemistry, U.S.S.R., page 2025 (1946), reported that only a 50 percent yield of pyromeconic acid was obtained when equal amounts of comenic acid and copper powder were heated. It has since been found that the yield of comenic acid is not improved, but is, in fact, lowered if the decarboxylations are carried out under the so-called "classical" conditions. Thus, heating comenic acid with copper, copper bronze and copper salts in the presence, or absence of, quinoline led to pyromeconic acid in 15 to 50 percent yield. It was, therefore, surprising to find that, if comenic acid is heated in the presence of certain selected solvents, it is smoothly decarboxylated to pyromeconic acid and to find further a copper catalyst is not required for this reaction. Thus it is surprisingly found that pyromeconic acid can be obtained from comenic acid in 80 percent yield by the improved process contemplated by the present invention which comprises heating comenic acid in a solvent selected from the group consisting of naphthalene and mono- and di-lower alkylnaphthalenes said alkyl groups containing up to 4 carbon atoms; tetrahydronaphthalene and mono- and di-lower alkyl tetrahydronaphthalenes said alkyl groups containing up to 4 carbon atoms; diphenyl ether and mono- and dialkyl and mono- and dialkoxy-substituted diphenyl ethers said alkyl and alkoxy groups containing up to 4 carbon atoms; polyglycol diethers and monoether monoesters of the formula

$$RO(CH_2CH_2O)_nR'$$

wherein n is an integer of from 2 to 6, R is selected from the group consisting of lower alkyl or phenyl; and R' is selected from the group consisting of lower alkyl, lower acyl and phenyl, said lower alkyl and lower acyl groups containing up to 4 carbon atoms; triphenyl phosphite and phosphate and their mononuclear lower alkylated derivatives said lower alkyl groups containing up to 4 carbon atoms; aliphatic cyclic amides of the formula



wherein R is alkyl containing from 4 to 8 carbon atoms; monocarboxylic saturated aliphatic open-chain acids containing from 8 to 16 carbon atoms; and di-lower alkyl esters of phthalic acid and its mononuclear lower alkyl-substituted derivatives said lower alkyl groups having up to 4 carbon atoms to a temperature of at least that at which carbon dioxide is evolved, maintaining said temperature until evolution of carbon dioxide substantially ceases and recovering the pyromeconic acid which forms.

While it has been found that a catalyst is not necessary to obtain the improved yields resulting from application of the process of the invention, the addition of a copper salt such as cupric acetate may be advisable in some cases when a shortened reaction time is desired.

The temperature at which the decarboxylation may be carried out varies over a wide range. However at temperatures below about 170° C., the rate of decarboxylation is too slow to be feasible and at temperatures above about 400° C. there exists a tendency for the yield of pyromeconic acid to be lowered because of secondary reactions. It is especially preferred to carry out the decarboxylation reaction at a temperature of from about 215 to about 250° C.

It is critical to the improved process of the present invention that the proper solvent be employed; not all sol-

vents which boil in the same general range can be employed. For example when glycerol, saturated hydrocarbons, of which decalin is an example, mineral oil, N,N-diethyltoluamide, o-nitrochlorobenzene, nitrobenzene, quinoline and carbazole are used in the process of the present invention, pyromeconic acid is isolated in low yield or not at all. If, on the other hand, diaryl ethers, triaryl phosphites and phosphates, di-lower alkyl phthalates, glycol ethers, of which tetraethylene glycol dimethyl ether is an example, N-alkylpyrrolidones, of which N-cyclohexylpyrrolidone is an example, aromatic hydrocarbons, of which α-methylnaphthalene is an example, organic acids, of which isodecanoic acid is an example, and di-lower alkyl phthalates, of which dimethyl phthalate is an example, are employed the marked improvement in yield of pyromeconic acid is observed.

It is desirable to select a solvent which is not substantially more volatile than pyromeconic acid at the reaction temperature. For example, a solvent can be selected which is relatively higher boiling than pyromeconic acid and which will remain in the vessel during distillation of pyromeconic acid therefrom. Alternatively, a somewhat more volatile solvent may be employed and that portion which co-distills with the pyromeconic acid may be separated and re-used. Volatility of the solvent is not critical to the invention, however, since other embodiments may be employed wherein the pyromeconic acid remains in the reaction vessel and is separated from the solvent as, for example, by selective extraction into an appropriate third solvent which has no solvent power for the said decarboxylation solvent. Thus the comenic acid may be heated in a vessel in the presence of a water-immiscible solvent until substantially completely converted to pyromeconic acid and then the pyromeconic acid may be separated from the solvent by extraction into water.

Other desirable, but not critical, considerations in the selection of the solvent for practice of the process of this invention are: that its initial cost be low, that it be thermally stable, that it be relatively unreactive toward comenic and pyromeconic acids, that it be a low-viscosity liquid at room temperature, that it have low solubility for pyromeconic acid at room temperature, that it be non-toxic and that it have little smell or taste.

In an especially preferred embodiment of the improved decarboxylation process of the present invention, a suspension of crystalline comenic acid in from about 1 to about 3 volumes of solvent is placed in a reaction vessel and the mass is heated to about 215° C. A vacuum of about 150 mm. of mercury is applied to the system and the pyromeconic acid distills as it is formed. Most of the carbon dioxide is evolved during about 3 hours at this temperature and heating is continued until the pyromeconic acid ceases to distill. At the end of about 6 hours there is obtained an 80 percent yield of pyromeconic acid; the small amount of solvent which co-distills is separated from the product and can be returned to the reaction vessel.

Alternatively, a slurry of about equal parts of comenic acid and solvent may be added to the reaction vessel containing an equal volume of solvent heated to about 250° C. This embodiment provides for a reduction in reaction time of up to 50 percent and has no significant effect on the overall yield and purity of the pyromeconic acid.

With respect to step (3), the conversion of pyromeconic acid to hydroxymaltol, a significant improvement in yield is obtained according to the process of the present invention. It is known to the art that pyromeconic acid can be converted to hydroxymaltol in 65 percent yield by treatment with formaldehyde. These moderate yields as reported by Shemyakin et al, in volume 85, Doklady Acad. Nauk., U.S.S.R., pages 1301–1304 (1952) were obtained by carrying out the reaction in alcoholic solution in the presence of excess formaldehyde and with sodium acetate catalyst at a pH of up to about 8. Furthermore, in view of the known instability of gamma-pyrones in alkaline media and of the tendency of gamma-pyrones such as kojic acid to dimerize to 6,6-bis-condensation products when treated with formaldehyde in the presence of strong base, it was surprisingly found that pyromeconic acid in aqueous solution at a pH of at least about 8 is converted in high yields to hydroxymaltol by treatment with an approximately molecular equivalent of formaldehyde. It was also not to be expected that no dimerization of hydroxymaltol occurs under these conditions. Thus it is found that at least 85 percent yields of hydroxymaltol are obtained by the improved process of the present invention which comprises adjusting the pH of a solution of pyromeconic acid to at least about 8 before adding an approximately molecular equivalent of formaldehyde thereto.

Furthermore, it is surprisingly found that, if the reaction is carried out in an alcohol containing from 1 to about 3 carbon atoms, it is possible to obtain hydroxymaltol in yields of up to 90% if the treatment with formaldehyde is carried out in the presence of a substantially stoichiometric proportion, based on the pyromeconic acid, of a strong base selected from the group consisting of alkali metal hydroxides, such as sodium hydroxide, potassium hydroxide and the like, and alkaline earth metal hydroxides, such as calcium hydroxide and the like.

In aqueous media, the means for bringing the pH to at least 8 is not critical to the improved process of the present invention. Thus, bases such as sodium hydroxide, potassium hydroxide, lithium hydroxide, and the like can be used.

The method for adjusting the pH of the aqueous solution of pyromeconic acid to at least about 8 is not critical to the present invention. Thus the base may be dissolved in water and added to a solution of pyromeconic acid or, alternatively, the pyromeconic acid may be added to a solution of the base and the base and pyromeconic acid may be added either in solid form or as a solution.

For optimum yields, it is preferred to limit the amount of formaldehyde added to one mole equivalent based on the pyromeconic acid. The use of an excess of formaldehyde may decrease the purity of the product if an aqueous medium is employed.

As will be exemplified hereinafter, above pH 8 there are effects on reaction rate, yield and purity which appear to be due to the pH at which the reaction is carried out. Thus, the reaction time required to obtain highest yield decreases as the pH is increased from 8 through 10, the total yield increases and the product purity increases. Since there is a tendency for yield and purity to decrease at pH's above 10, for example, 13, it is preferred to carry out this step of the process at pH 10. It is not critical to the present invention that the formaldehyde be added in any particular form. Thus, the usual aqueous formulations of 37 and 30 wt.-percent, and the like, the commercial alcoholic formaldehyde solutions, the condensed forms of formaldehyde such as trioxymethylene and paraform and gaseous monomeric formaldehyde may be employed. It is particularly preferred from the standpoint of ease in handling to use aqueous formalin.

The following represents a preferred embodiment of the improved process of the present invention: pyromeconic is added to about four times its weight of water and to the stirred mixture is added sufficient 50 percent by weight aqueous sodium hydroxide solution to bring the pH of the resulting mixture to 10. This weight of caustic solution is equivalent to about ½ the weight of the pyromeconic acid originally taken. To this solution is added one mole equivalent of formaldehyde as a 37 percent by weight aqueous solution. The reaction temperature rises spontaneously from about 25° to about 35–40° C. in a short time and the clear reaction mixture is held for about three hours at a temperature of about 35° C. by running cooling water through the vessel jacket. The hydroxymaltol is isolated by adjusting the pH of the reaction mixture to 5 by adding 12 N hydrochloric acid solution. The slurry is cooled to about 5° C., is stirred for about 30

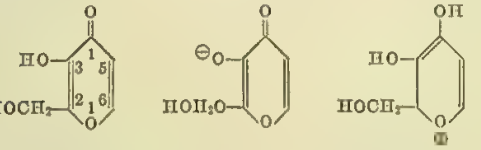
minutes and the product is removed by filtration. The filtrate can be further concentrated to about ⅓ volume and an additional amount of hydroxymaltol can be isolated. The combined yield of hydroxymaltol obtained according to the procedure outlined is of the order of 87 percent. Alternatively, as will be disclosed more fully hereinafter, the hydroxymaltol may be converted into maltol without isolation from solution. Since this procedure eliminates a filtration step, it is a preferred embodiment in the process of preparing maltol from kojic acid.

With respect to the final step (4) in the process of the present invention, it has been surprisingly found that hydroxymaltol may be converted directly to maltol in high yield. Previously, maltol has been prepared from hydroxymaltol only by first converting hydroxymaltol to chloromaltol and converting the chloromethyl group thereof to a methyl group. It is also known that kojic acid, an isomer of hydroxymaltol which has the hydroxymethyl group in the 6 instead of in the 2-position, cannot be reduced to allomaltol in good yield. In fact, yields of allomaltol of above 9 percent have not been obtained by the direct reduction of kojic acid under the same conditions which have led to yields of 90 percent of maltol from hydroxymaltol.

The present invention therefore contemplates a one-step process for the preparation of maltol which comprises treating with a reducing agent a solution of hydroxymaltol wherein the 3-hydroxyl group of said hydroxymaltol is substantially completely in the un-ionized form.

It is critical to the process of the instant invention that the hydroxymaltol species being treated is substantially in its un-ionized form.

It is known that hydroxymaltol exists in several distinct forms depending upon the relative acidity of the medium in which it is dissolved. Three of these species may be represented by the following formulas:



Hydroxymaltol — I

Hydroxymaltol anion — II

Pyrillium cation — III

If the hydroxymaltol species in solution is predominately of the hydroxymaltol anion form (II), the yield of maltol is very low after treatment of the solution with reducing agent. If, on the other hand, the hydroxymaltol is predominately in the form wherein the 3-hydroxyl group is substantially completely un-ionized, yields of 30–90 percent of maltol are obtained in one step by reduction.

In aqueous solution, titration data indicate that hydroxymaltol is predominately in the required (I) form within the pH range of up to about 8.8. Therefore, if an aqueous medium is employed, it is required to carry out the process of the present invention within this pH range. If it is desired to carry out the reaction in other appropriate solvents as, for example, alcohols, acids, and the like, it is obvious that consideration must be given to the effect of the acidity of the medium on the tendency of one of the particular forms of hydroxymaltol to predominate. The range of operable acidity in any solvent can be determined readily by commonly employed techniques. One particularly advantageous method is to titrate a solution of hydroxymaltol in the selected solvent medium and from these data to determine the points of dissociation of the respective species.

The nature of the solvent to be employed in the process of this invention is not critical as long as it is inert with respect to the reducing agent employed. Thus it is

feasible to employ, for example, water, lower alkanols such as methanol, ethanol, isopropanol, and the like, and acetic acid either singularly or in admixture.

The temperature at which the reduction is carried out is not critical to the process of the present invention. Thus, the one-step reduction can be carried out over a range of from about 5° to about 125° C. Since there is some tendency for undesirable side reactions to occur at the extremes of this range, it is usually preferred to conduct the reaction in a range of from about 25° to about 75° C., and it is especially preferred to maintain the reaction temperature at about 55–60° C. The time required for completion varies with the type of reducing agent employed and also with the temperature of the reaction. It has been found, for example, that if the reduction is carried out with zinc and an acid at a pH of about 1, and at a temperature of 55–60° C. the hydroxymaltol has been substantially completely consumed after about 4 hours.

As has been mentioned hereinbefore, the starting material may be hydroxymaltol isolated from the hydroxymethylation of pyromeconic acid. This may be redissolved in the solvent to be employed in the subject reduction step. An alternative, and preferred embodiment of the process of the present invention, however, is to reduce the hydroxymaltol directly and without prior isolation. As is obvious, this preferred embodiment eliminates a filtration step.

According to the process of this invention, the clear hydroxymaltol solution prepared as described above in the hydroxymethylation of pyromeconic acid or, alternatively, made by adding about one part of hydroxymaltol to about 5 parts of water is treated with enough 50 wt.-percent aqueous acid, for example, sulfuric or hydrochloric, to bring the pH to below about 5. The slurry is then heated to about 50–55° C. and an amount of zinc dust equivalent to the weight of contained hydroxymaltol is added. This is equivalent to about 2 moles of zinc dust per mole of hydroxymaltol, i.e., a 100 percent excess, although with certain grades of zinc dust, less may be required. The reason for the variation in efficiency between certain grades of zinc dust is not clearly understood at the present time although in some cases about 1.3 moles of zinc per mole of hydroxymaltol has been found to be sufficient. The reaction mixture is then stirred vigorously and an aqueous solution of about 10 N hydrochloric acid containing at least a stoichiometric amount of acid based on the hydroxymaltol present is slowly added over a period of about one hour. It is required that the temperature be carefully maintained below about 60° C. otherwise there is a tendency for the reaction mixture to boil uncontrollably. After all of the acid has been added the reaction mixture is maintained at about 55–60° C. for from about 3 to about 5 hours.

The extent of completion of the reaction may be determined by a paper chromatographic assay of the reaction mixture using pure hydroxymaltol as a reference. A suitable developing medium for said assay is comprised of 2 parts of chloroform, 2 parts of 90 percent formic acid and 1 part of dilute ethanol which is prepared by mixing 36 parts of Specially Denatured Alcohol No. 3A with 4 parts of water. The hydroxymaltol spots are viewed with a 254 millimicron lamp and ultraviolet scanner, and then sprayed with a 1 percent ferric chloride solution. When the hydroxymaltol spot from the reaction mixture is weak or has disappeared the reduction is considered complete.

When the assay indicates the reaction to be complete, the maltol can be isolated according to the following procedure: the mixture is heated and then is brought to a pH of about 2 by the addition of a 50 wt.-percent solution of sodium hydroxide. For best filtration results, the temperature should reach about 90–95° C. during this step. Unreacted zinc is removed by passing the reaction mixture through a filter, preferably preheated to minimize

plugging and the zinc is washed with an amount of hot water equivalent to about 10 percent of the total reaction mixture. The filtrate is then cooled to about 5–10° C. to precipitate the maltol; it is preferred to cool the filtrate slowly during about 3 to 4 hours as this gives maltol in a more easily filterable form. The crystalline product is removed by filtration and, after washing with an equal amount of cold water, is dried by standard techniques. An especially advantageous method comprises drying the maltol at about 60° C. in a vacuum of about 100–200 mm. Hg until it is substantially free of solvent and then reducing the temperature to about 40° C. to finish the drying process. If the entire drying operation is carried out at 60° C., there is some tendency for the maltol to sublime.

A number of reducing means may be employed in the process of this reaction. For example, in addition to the zinc-hydrochloric acid couple described above there may be used other metal-acid couples, or, alternatively, chemical reducing agents or, hydrogen and a catalyst may be used. It is not feasible to employ strongly basic reagents such as sodium and alcohol to effect the reduction since these are usually only effective in media wherein hydroxymaltol would exist predominately in its anionic species (II).

With respect to the employment of metal-acid couples as the reducing agent it has been found that zinc, iron, aluminum, tin, magnesium, and the like, are effective to displace hydrogen from the acid. It is especially preferred to use zinc since this metal, in addition to its economic advantage, has a tendency to provide maltol of somewhat higher purity and lighter color. Mineral or monocarboxylic saturated open-chain aliphatic acids that have from 1 to 10 carbon atoms and which are soluble in the reaction system can be employed in combination with metals of the aforesaid type. Among the mineral acids which are particularly effective are hydrochloric and sulfuric acid and among the organic acids which are particularly effective are formic and acetic. It is especially preferred to use hydrochloric acid in this reaction since the maltol formed has a tendency to be obtained in higher yield and in higher purity.

Maltol may be obtained by the process of this reaction if a chemical reducing agent such as hydrosulfurous acid, or an alkali or alkaline earth metal salt thereof is employed. For example, there can be used sodium, potassium, lithium, calcium, and magnesium hydrosulfite, and the like. Especially preferred because it is freely available, economical and an especially strong reducing agent is sodium hydrosulfite. The use of this reagent in the one-step reduction of hydroxymaltol to maltol will be exemplified in detail hereinafter.

Another effective reducing means to be employed in the process of this invention is hydrogen. It is necessary to use a noble metal catalyst to effect the reduction with hydrogen and it has been found that the best yields are obtained at a pH range of from about 1 to about 3.

Strong maltol spots by paper chromatographic assay techniques are obtained after reductions of mixtures at pH 1, 2 and 3, respectively, and yields of 30 percent of maltol are obtained after isolation. The type and form of the noble metal catalysts employed have not been found to be critical to the invention. Thus, platinum and palladium either in the form of the finely divided metals or supported on carbon or charcoal may be used. It is especially preferred to use palladium on carbon catalyst because of its high activity. The use of hydrogen and a catalyst as a reducing means for the direct conversion of hydroxymaltol to maltol is exemplified in detail hereinafter.

Of course, as is obvious, as one embodiment of this invention maltol may be obtained starting with meconic acid instead of kojic acid. As is exemplified hereinafter, meconic acid, which is 2,6-dicarboxy-3-hydroxy-gamma-pyrone and is obtained as an opium derivative, may be decarboxylated by the process sequence represented by steps (2*a*) and (2) of the instant invention to form pyromeconic acid, the pyromeconic acid may be converted to hydroxymaltol by step (3) of the instant invention and the hydroxymaltol may be converted to maltol by step (4) of the instant invention. These and the above steps are illustrated in the attached drawing.

This application is a continuation-in-part of the application of Robert L. Miller, Serial No. 154,036, filed November 21, 1961, and now abandoned, and assigned to the assignee of the present application.

The procedures referred to above are illustrated in the flow diagram.

The following examples are illustrative of the process of this invention.

Example I

In an 8-liter stainless steel vessel fitted with a stirrer and an air sparger is placed a suspension of 350 grams of kojic acid in 3500 ml. of water. The pH is adjusted to 11.1 by addition of 256 ml. of 50 percent aqueous sodium hydroxide and then 142 g. (7.1 g. as metal) of a 5 percent palladium on charcoal catalyst is added. Air is passed into the suspension at a rate of about 2100 ml. per minute. The reaction, which is slightly exothermic, is maintained at a temperature of about 20–22 degrees C. by occasional application of external cooling. After 11 hours the reaction mixture is filtered to remove the catalyst and is treated with 600 ml. of concentrated hydrochloric acid. The crystals of comenic acid which precipitate from the pH 0.5 mixture are removed by filtration, washed with a small amount of cold water and are air-dried. There is obtained 328 g. of product. This is 85.3 percent of the theoretical yield. Titration data indicate the product to be 99.2 percent pure; therefore, there is obtained an 84.6 percent yield of comenic acid as corrected for purity.

Example II

The procedure of Example I is repeated at 10 degrees, 30 degrees, 40 degrees, and 55 degrees centigrade with substantially the same yield (70–85 percent) of comenic acid being obtained at 10 degrees, 30 degrees and 40 degrees. At 55 degrees centigrade there is obtained a lower yield of a darker brown-colored product.

Example III

The procedure of Example I is repeated substituting the following catalysts for palladium on charcoal; platinum black, palladium black, platinic oxide and platinum on charcoal. In all cases, 7.1 g. of catalyst calculated as metal was used. Substantially the same results are obtained.

Example IV

The procedure of Example I is repeated substituting oxygen for air and decreasing the flow rate to about one-fourth. Substantially the same results are obtained.

Example V

A filtered-reaction mixture prepared as in Example I is adjusted to a pH of below 1 by addition thereto of sulfuric acid and a high yield of high purity comenic acid is obtained. The procedure is repeated substituting nitric acid for hydrochloric acid and substantially the same result is obtained.

Example VI

The procedure of Example I is repeated substituting 250 g. of potassium hydroxide (added as a 50 percent aqueous solution) for the corresponding sodium hydroxide solution. Substantially the same results are obtained.

The procedure of Example I is repeated substituting 110 g. of lithium hydroxide (added as a 10 percent aqueous solution) for the corresponding sodium hydroxide solution. Substantially the same results are obtained.

Example VII

In a 150-ml. Pyrex flask fitted with a mechanical stirrer and a thermometer and connected through a distillation head to a receiver are placed 10.0 g. of comenic acid prepared as described in Example I and 30 ml. of diphenyl ether. The reaction mixture is stirred and heated by application of a heating mantle. After about 20 minutes, the temperature reaches 225° C. and gas is observed to pass into the receiver. When the temperature reaches 245–250° C., a vigorous evolution of carbon dioxide is observed. After an additional 40 minutes at 245–250° C., the pyromeconic acid is distilled therefrom until no more passes over at an internal temperature of 255° C. and a vapor temperature of 230° C. Thirty ml. of additional diphenyl ether is added to the reaction flask and a second fraction is obtained after distillation at 255° C. internal temperature for an additional 1 hour and 10 min. The product is suspended in about 5 volumes of hexane, then is removed by filtration, and is recrystallized in 4 volumes of toluene. There is obtained 5.71 g. of pyromeconic acid, M.P. 113–115.5. Concentration of the toluene mother-liquors to about 1/20 volume affords an additional 0.7 g. of somewhat less pure pyromeconic acid. The combined weight of pyromeconic acid obtained represents an 80% conversion.

The procedure is repeated substituting tricresyl phosphate for the diphenyl ether; an 80% yield of pyromeconic acid is obtained. The procedure is repeated substituting dimethyl phthalate for diphenyl ether; substantially the same results are obtained.

Example VIII

The procedure of Example VII is repeated substituting the following solvents for diphenyl ether:

Naphthalene
1-methylnaphthalene
2-ethylnaphthalene
3-methylnaphthalene
3-t-butylnaphthalene
1,2-dimethylnaphthalene
1,4-dimethylnaphthalene
1,8-methylpropylnaphthalene
Tetrahydronaphthalene
1-methyltetrahydronaphthalene
8-methyltetrahydronaphthalene
1,4-dimethyltetrahydronaphthalene
6-ethyltetrahydronaphthalene
1,8-methylpropyltetrahydronaphthalene
2-methyl diphenyl ether
3-methyl diphenyl ether
4-ethyl diphenyl ether
4-methyl diphenyl ether
4,4'-dimethyl diphenyl ether
2,2'-dimethyl diphenyl ether
2,4-dimethyl diphenyl ether
Triethylene glycol dibutyl ether
Triethylene glycol diphenyl ether
Tetraethylene glycol dimethyl ether
Hexaethylene glycol dimethyl ether
Triphenyl phosphite
4,4',4''-trimethyltriphenyl phosphite
2,2',2''-trimethyltriphenyl phosphite
3-t-butylphenyl diphenyl phosphite
2,2',2''-trimethyltriphenyl phosphate
4,4',4''-trimethyltriphenyl phosphate
3-t-butylphenyl diphenyl phosphate
N-butyl pyrrolidone
N-cyclohexyl pyrrolidone
N-2-ethylhexyl pyrrolidone
Caprilic acid
Lauric acid
Palmitic acid
Isodecanoic acid
Diethylene glycol monobutyl ether monobutyrate
Triethylene glycol monomethyl ether monoacetate

Hexaethylene glycol monomethyl ether monoacetate
Diethylene glycol monobutyl ether acetate
Triethylene glycol monophenyl ether monoacetate
Diethylene glycol monomethyl ether monobenzoate
Diethyl phthalate
Dibutyl phthalate
Dimethyl terephthalate
Dimethyl isophthalate
Dimethyl 3-i-propylphthalate
Dimethyl 2,3-dimethylphthalate

Substantially the same results are obtained.

Example IX

In a 5-gallon stainless steel reaction vessel fitted with a mechanical stirrer, thermometer and distillation receiver are placed 1750 g. of comenic acid prepared as described in Example I and 2675 ml. of dimethyltetraethylene glycol (Ansul Ether E–181). A vacuum of 130–160 mm. of Hg is applied to the system and the reaction mixture is heated to 210–215° during about 1 hour and heating is continued for an additional 8 hours. When the reaction temperature reaches 210°, the vigorous evolution of carbon dioxide is observed and pyromeconic acid begins to distill from the vessel. At the end of the reaction, pyromeconic acid has ceased to distill. During the reaction the solvent which codistills with the product is returned periodically to the vessel. The pyromeconic acid is collected and is suspended in about 5 volumes of hexane and the product is recovered from the suspension by filtration. After drying there is obtained pyromeconic acid in an amount representing a 76 percent yield.

The procedure is repeated reducing the amount of solvent to 2175 ml. and adding the comenic acid semicontinuously to the hot mixture during 2.7 hours. No vacuum is applied to the system. A yield of pyromeconic acid corresponding to 80 percent of theory is obtained.

Example X

In a 2-l. Pyrex flask are placed 1000 ml. of absolute methanol and 100 g., 0.89 mol of pyromeconic acid prepared as in Example IX. To this solution is added slowly 90 g. of a 50 wt.-percent aqueous solution of sodium hydroxide; the pH of the resulting solution is about 10. The reaction mixture which has spontaneously reached a temperature of about 35° C. during said addition is treated with 154 ml. of a 37% aqueous solution of formaldehyde. The reaction mixture is stirred for about 16 hours, during which time the solid phase changes in appearance, then is treated with a solution of 35 ml. of concentrated sulfuric acid in 65 ml. of water. The reaction mixture is then evaporated to near dryness at a temperature of about 50° C. and a pressure of about 15 mm. and the solids are extracted with 2–750 ml. portions of isopropanol heated to about 90° C. Concentration of the combined isopropanol extracts to about 1000 ml. causes a first crop of hydroxymaltol to precipitate and this is removed by filtration. Further concentration of the isopropanol filtrate to about 500 ml. causes a second crop of hydroxymaltol to precipitate. A third crop is obtained by concentration of the hydroxymaltol to about 250 ml. The combined weight of hydroxymaltol obtained is 107.4 g.; this corresponds to an 84.6 percent yield.

The procedure is repeated substituting isopropanol for the methanol reaction solvent. Substantially the same results are obtained.

The procedure is repeated substituting for the sodium hydroxide stoichiometrically equivalent amounts of the following bases: lithium hydroxide, potassium hydroxide and calcium hydroxide. Substantially the same results are obtained.

Example XI

Pyromeconic acid, 1000 g., 8.92 moles, prepared as described in Example IX is dissolved in 4.9 liters of water in a stainless steel vessel. The pH is adjusted to 10.0

with 447 ml. (8.47 moles) of 18.9 N sodium hydroxide solution. Then 669 ml., 8.92 moles, of 37% by weight aqueous formaldehyde is added. The temperature spontaneously rises to 45° C. then gradually decreases to 29° C. during a 2 hour stirring period. The hydroxymaltol is precipitated from the clear solution by adjusting the pH to 5 with 705 ml. of 12 N hydrochloric acid. The slurry is cooled to 5° C., stirred for 30 minutes and is filtered. The hydroxymaltol is washed with 3 liters of ice water and is vacuum dried. The first crop of hydroxymaltol, M.P. 154–5° C., weighs 949 g. and represents 75% of the theoretical yield. Concentration of the 9.5 liters of mother liquor to about 2 liters in a vacuum of about 20 mm. Hg yields a second crop of 152 g. The total yield of hydroxymaltol, therefore, is 87 percent of the theoretical.

The procedure is repeated substituting appropriate amounts of 18.9 N aqueous sodium hydroxide solution for the 447 ml. used hereinbefore and adjusting to the respective pH's tabulated hereinafter. It is found that as the pH is increased over the range of from 6 to 13 the reaction rate increases as measured by yield as a function of time. The results are given in terms of yield at the optimum reaction times.

pH	Optimum Time, hrs.	Percent Yield of Hydroxymaltol	
		Total	M.P. >130° C., Percent
6	24	53	0
7	24	67	66
8	10	77	70
9	3	86	78
10	1.5	85	82
13	1.5	73	68

The percent of the product melting above 130° C. is a measure of its purity. Thus it is observed that at pH's of above about 8 there is a significant increase in both the yield and purity of the hydroxymaltol and a decrease in the optimum reaction time. It is also observed that at pH 13 there tends to be a decrease in yield and purity although the optimum reaction time remains unchanged. At a pH of 5, a somewhat lower than 50% yield of hydroxymaltol is obtained.

Example XII

In a 300-ml. Pyrex flask fitted with a magnetic stirrer, condenser and addition funnel is placed 10.0 (0.07 mole) of hydroxy maltol prepared as in Example XI, 10.6 g. (0.16 g.-atom) of zinc dust, 60 ml. of water and 50 drops of a 1% aqueous solution of cupric sulfate. The reaction mixture is stirred and heated to reflux and 34 ml. of concentrated hydrochloric acid is added dropwise during about ½ hour. After 2 hours of refluxing, the reaction is filtered hot to remove unreacted zinc and the pH of the filtrate is adjusted to pH 10 by the addition of a 20% aqueous sodium hydroxide solution. The precipitated zinc hydroxide is removed by filtration and is washed with 30 ml. of water at 60° C. The combined filtrates are adjusted to pH 4 with 20% aqueous hydrochloric acid and, after cooling to about 10° C., the crop of crystals of maltol are collected by filtration. There is obtained 3.97 g. of maltol, M.P. 156–158° C. Extraction of the filtrate with 5–50 ml. portions of chloroform and evaporation of the chloroform yields an additional 2.12 g. of maltol. The combined weight of product is 6.09 g.; this represents a 69 percent yield.

The procedure is repeated this time without using the copper sulfate solution. Substantially the same results are obtained.

The procedure is repeated substituting for the zinc dust, stoichiometrically equivalent amounts of the following metals: iron, aluminum, tin and magnesium. Substantially the same results are obtained.

The procedure is repeated substituting for the hydrochloric acid stoichiometrically equivalent amounts of the following organic acids: formic, acetic and isodecanoic. With the C–10 acid, it is desirable to add an appropriate quantity of a co-solvent to the predominately aqueous system to promote solubility.

Substantially the same results are obtained.

Example XIII

Hydroxymaltol, 10 g., is dissolved in 100 ml. of water and the pH of the solution is adjusted to 1 by the addition of 10% hydrochloric acid solution. To the reaction mixture is added 1.0 g. of a commercial 10% palladium on charcoal catalyst and the suspension is shaken in a hydrogenation apparatus at 25° C. under an initial hydrogen pressure of 50 pounds per square inch gauge. When an amount of hydrogen equivalent to 1 mole per mole of hydroxymaltol has been taken up, the reaction is stopped, the reaction mixture is filtered, and the solvent is evaporated from the reaction mixture. The residue is recrystallized by dissolving it in 100 ml. of water at 95° C. then cooling the solution to 1° C.; there is obtained 2.1 g. of maltol of high purity. This corresponds to a yield of 30 percent of the theoretical.

The procedure is repeated substituting the following catalysts for palladium on charcoal on an equal weight based on the metal basis: platinum black, palladium black, platinic oxide and platinum on charcoal. Substantially the same results are obtained.

Example XIV

Sodium hydrosulfite, 1180 g., is dissolved in 11.4 liters of water in a 22-liter Pyrex glass flask. The pH of the solution is 5.8. To this solution at 25° C. is added 575 g. of hydroxymaltol during a 20 minute period together with portions of a 10 N aqueous sodium hydroxide solution as required to maintain the pH at 5.0–5.5. The reaction mixture is stirred for 30 minutes, then is heated to 90° C. during an additional 30 minutes. A small amount of a solid impurity is removed by filtration of the hot solution, then the filtrate is cooled to 15° C. After stirring for an additional 30 minutes at 15° C., the maltol is removed by filtration and is washed with 1.4 liters of ice-water. Extraction of the filtrate with four 6 liter portions of chloroform and evaporation of the chloroform yields are second crop of maltol. There is obtained 173 g. of maltol; this represents a 30% yield of theoretical.

The procedure is repeated substituting for the sodium hydrosulfite the following salts: lithium hydrosulfite, potassium hydrosulfite, calcium hydrosulfite and magnesium hydrosulfite. Substantially the same results are obtained.

Example XV

Kojic acid is converted to comenic acid in 85% yield by the procedure described in Example I. Comenic acid is decarboxylated to pyromeconic acid in 76% yield by the procedure described in Example IX. To a 100 gallon glass lined vessel is added 44.5 gallons of water and 75 lbs. (0.67 lb. mole) of pyromeconic acid. The mixture is stirred and 4 gallons of 50% aqueous sodium hydroxide solution is added and the final pH is 10. During the addition of sodium hydroxide the temperature rises and cooling water is used to prevent the temperature from exceeding 40° C. Six gallons of a 37% aqueous solution of formaldehyde is added and within several minutes, the temperature shows a tendency to increase. It is held in the range of 35–40° C. by application of cooling water for approximately 3 hours. To the clear reaction mixture is added 5.8 gallons of 50% sulfuric acid solution, the resulting mixture is heated to 50–55° C. and 87.5 lbs. of zinc dust is added. The suspension is strongly agitated and 32.3 gallons of 10 N hydrochloric acid solution is slowly added during 45 minutes and the temperature is maintained at 55–60° by means of cooling water. After an additional 4 hours at 55–60° C., paper chromatographic assay shows the hydroxymaltol to have been com-

pletely reacted. The mixture is heated and simultaneously neutralized to pH 2 with 50 percent sodium hydroxide solution (6 gallons) and the final temperature is 90–95° C. The zinc is filtered on a 24-inch preheated porcelain filter and is washed with 3 gallons of water at 80–90° C. The combined filtrates are cooled slowly over a period of 3 to 4 hours to 5–10° C. and the crystalline maltol which precipitates is collected on a 24-inch porcelain filter. The filter cake is washed with 10 gallons of cold water and is dried in a vacuum of 100 mm. of Hg first at 60° C. until nearly free of water, then at 40° C. until completely dry. There is obtained 60 lbs. of maltol, M.P. 159–160° C., with a sulfate ash content of less than 0.5%, and indicated to be of 98–100% purity by assay. Extraction of the filtrate with 5½ volumes of chloroform and evaporation of the chloroform extracts yields an additional 20% yield of somewhat less pure maltol. The combined yield of maltol based on pyromeconic acid is 91% of the theoretical. The yield of maltol based on kojic acid therefore is 59 percent.

Example XVI

The procedure of Example IX is repeated substituting 10 g. of meconic acid, obtained by extraction from opium, for the corresponding comenic acid. This material is decarboxylated under the same conditions by this procedure to yield pyromeconic acid. The pyromeconic acid is converted to hydroxymaltol by following the procedure of Example XI to the point immediately prior to precipitation with 12 N hydrochloric acid. The hydroxymaltol in the clear solution is treated with 2 gram-atomic equivalents of zinc dust and 2 moles of hydrochloric acid per gram atomic weight of zinc as described in Example XII and the maltol formed in situ thereby is recovered as described therein. Maltol of very high quality is obtained.

What is claimed is:

1. The process which comprises treating kojic acid with oxygen in the presence of a noble metal catalyst at a pH of at least about 10 to form comenic acid, decarboxylating said comenic acid to form pyromeconic acid, treating the pyromeconic acid with formaldehyde at a pH of at least about 5 to form hydroxymaltol and reducing the hydroxymaltol under acidic to substantially neutral conditions to form maltol.

2. The process which comprises treating kojic acid with oxygen in the presence of a noble metal catalyst at a pH of at least about 10 to form comenic acid, decarboxylating said comenic acid to form pyromeconic acid and treating the pyromeconic acid with formaldehyde at a pH of at least about 5 to form hydroxymaltol.

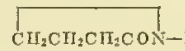
3. The process which comprises decarboxylating a compound selected from the group consisting of comenic acid and meconic acid to form pyromeconic acid, treating the pyromeconic acid with formaldehyde at a pH of at least about 5 to form hydroxymaltol and reducing the hydroxymaltol under acidic to substantially neutral conditions to form maltol.

4. In a process for direct oxidation of kojic acid to the corresponding 2-carboxylate by treatment of an aqueous solution of kojic acid with oxygen in the presence of a noble metal catalyst, the improvement which comprises maintaining the pH of the said solution at a value of at least 10 during treatment with oxygen.

5. An improved process for the direct oxidation of kojic acid to comenic acid which comprises adjusting an aqueous kojic acid solution to a pH of at least 10 with an alkali metal hydroxide, introducing oxygen into said solution in the presence of a noble metal catalyst selected from the group consisting of finely-divided platinum, finely-divided palladium, platinum oxide, platinum on charcoal and palladium on charcoal, maintaining said minimum pH during oxygenation, continuing the oxygenation until the kojic acid alkali metal salt is substantially completely consumed, subsequently adjusting the pH to a value below about 2.5 with mineral acid and recovering the comenic acid thereby produced.

6. The process which comprises treating pyromeconic acid with formaldehyde at a pH of at least about 5 to form hydroxymaltol and reducing the hydroxymaltol in situ to form maltol.

7. An improved process for the preparation of pyromeconic acid from comenic acid which comprises heating comenic acid in a solvent selected from the group consisting of naphthalene and mono- and di-lower alkylnaphthalenes; tetrahydronaphthalene and mono- and di-lower alkyl tetra-hydronaphthalenes; diphenyl ether and mono- and di-lower alkyl and mono- and di-lower alkoxy-substituted diphenyl ethers; polyglycol diethers and monoether monoesters of the formula $RO(CH_2CH_2O)_nR'$ wherein n is an integer of from 2 to 6, R is selected from the group consisting of lower alkyl and phenyl and R' is selected from the group consisting of lower alkyl, lower acyl and phenyl; triphenyl phosphite and phosphate and their mononuclear lower alkylated derivatives; aliphatic cyclic amides of the formula



wherein R is alkyl containing from 4 to 8 carbon atoms; monocarboxylic saturated aliphatic open-chain acids containing from 8 to 16 carbon atoms; and di-lower alkyl esters of phthalic acid and its mononuclear lower alkyl substituted derivatives to a temperature of at least that at which carbon dioxide substantially is evolved, maintaining said temperature until evolution of carbon dioxide substantially ceases and recovering the pyromeconic acid which forms.

8. An improved process for the preparation of hydroxymaltol which comprises adding an approximately molecular equivalent of formaldehyde to an aqueous solution of pyromeconic acid adjusted to a pH of at least about 8.

9. An improved process for the preparation of hydroxymaltol which comprises reacting formaldehyde with pyromeconic acid in solution in an alcohol having from 1 to 3 carbon atoms and containing a substantially stoichiometric proportion, based on the pyromeconic acid, of a base selected from the group consisting of alkali metal hydroxides and alkaline earth hydroxides.

10. A one-step process for the preparation of maltol which comprises treating with a reducing agent a solution of hydroxymaltol wherein the 3-hydroxyl group of said hydroxymaltol is predominantly in the un-ionized form.

11. A process as in claim 10 wherein said reducing agent is a metal-acid couple, said metal being selected from the group consisting of zinc, iron, aluminum, tin and magnesium and said acid being selected from the group consisting of mineral acids and those monocarboxylic saturated open-chain aliphatic acids that have from 1 to 10 carbon atoms and are soluble in the reaction system.

12. A process as in claim 10 wherein said reducing agent is selected from the group consisting of hydrosulfurous acid and its alkali metal and alkaline earth metal salts.

13. A process as in claim 10 wherein said reducing agent is hydrogen activated by a noble metal catalyst.

14. A process for the preparation of maltol from kojic acid which comprises adjusting an aqueous kojic acid solution to a pH of at least 10 with sodium hydroxide, introducing oxygen into said solution in the presence of a palladium catalyst, maintaining said minimum pH during oxygenation, continuing the oxygenation until the kojic acid sodium salt is substantially completely consumed, subsequently adjusting the pH to a value below about 2.5 with mineral acid, recovering the comenic acid formed thereby, decarboxylating said comenic acid to pyromeconic acid, recovering said pyromeconic acid, adding an approximately molecular equivalent of formaldehyde to an aqueous solution of said pyromeconic acid adjusted to

a pH of at least about 8, recovering the hydroxymaltol formed thereby; treating with a zinc and hydrochloric acid reducing agent a solution of said hydroxymaltol wherein the 3-hydroxyl group of said hydroxymaltol is predominantly in the un-ionized form and recovering the maltol.

15. A process for the preparation of maltol from kojic acid which comprises adjusting an aqueous kojic acid solution to a pH of at least 10 with sodium hydroxide, introducing oxygen into said solution in the presence of a palladium catalyst, maintaining said minimum pH during oxygenation, continuing the oxygenation until the kojic acid sodium salt is substantially completely consumed, subsequently adjusting the pH to a value below about 2.5 with mineral acid, recovering the comenic acid formed

thereby, heating said comenic acid in diphenyl ether to a temperature of at least about 230° C., maintaining said temperature until evolution of carbon dioxide substantially ceases, recovering the pyromeconic acid formed thereby, adding an approximately molecular equivalent of formaldehyde to an aqueous solution of said pyromeconic acid adjusted to a pH of at least about 8, treating the solution of hydroxymaltol formed thereby wherein the 3-hydroxyl group of said hydroxy-maltol is predominantly in the un-ionized form with a zinc and hydrochloric acid reducing agent, and recovering the maltol which is formed.

References Cited in the file of this patent

Fieser et al.: Organic Chemistry, Third Edition, page 837, Reinhold Publishing Corp., New York (1956).

United States Patent Office 3,133,089 Patented May 12, 1964

3,133,089

PREPARATION OF GAMMA PYRONES

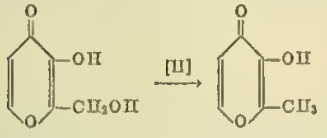
Robert P. Allingham, Groton, Conn., and Robert L. Miller, Brooklyn, and Herman Rutner, Queens Village, N.Y., assignors to Chas. Pfizer & Co., Inc., New York, N.Y., a corporation of Delaware

No Drawing. Filed June 13, 1962, Ser. No. 202,103
7 Claims. (Cl. 260—345.9)

The present invention relates to a process for the preparation of gamma-pyrones. More particularly it is concerned with an improved process for the preparation of maltol, a gamma-pyrone which is especially useful for its flavor and aroma-enhancing properties.

Until recently, the commercial production of maltol has depended upon difficult and expensive extraction processes involving natural products as, for example, wood. However, as has been disclosed in the copending application of Bryce E. Tate and Robert L. Miller, Serial No. 171,732, filed February 7, 1962, and assigned to the assignee of the instant application, it is now possible to prepare maltol on a commercial scale from a freely available and economical gamma-pyrone, kojic acid.

As is disclosed in the aforesaid application, maltol, 3-hydroxy-2-methyl-4-pyrone, can be obtained from hydroxymaltol, 3-hydroxy-2-hydroxy-methyl-4-pyrone, by a one-step reduction process:



hydroxymaltol maltol

The maximum yields of maltol tend to vary with the reducing means employed. With zinc and hydrochloric acid reducing agent, maltol is obtained in yields of up to 90%; with sodium hydrosulfite reducing agent, maltol is obtained in only about 30% yield and with hydrogen activated by noble metal catalysts maltol is obtained in only about 20% yield. Furthermore, it is found that if zinc and hydrochloric acid is employed as the reducing means there is some tendency for the maltol to be colored red due to the presence of a chelate of maltol with iron; iron seems to be present in small amounts in most samples of zinc employed in commercial reduction operations. This coloration can be removed from the product by a subsequent distillation step to obtain maltol eminently suitable for all food uses.

It has now been surprisingly found in the improved process of the present invention that if instead of being directly reduced to maltol as is described in the said pending application, the hydroxymaltol is first converted to a halomaltol such as, for example 2-chloro-, 2-bromo- or 2 - iodomethyl - 3 - hydroxy - 4 - pyrone (hereinafter designated, respectively, chloromaltol, bromomaltol and iodomaltol), and the halomaltol is then converted to maltol, very high yields of maltol can be obtained by reduction with salts of hydrosulfurous acid or with hydrogen activated by a noble metal catalyst. Furthermore the maltol which is obtained is not contaminated with the aforementioned iron chelate because it is not necessary, nor even desirable, in this instance to employ a metal-acid reducing means. As a result of the application of the improved process of this invention, therefore, maltol is obtained in a form which can be employed directly, without further purification steps, in all food uses.

It is known to the art that maltol can be made from hydroxymaltol by proceeding through a halomaltol intermediate. Thus, Stodola in volume 73, Journal of the American Chemical Society, pages 5912–13, 1951, and Shemyakin, et al. in volume 47, Chemical Abstracts, page

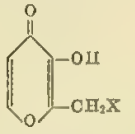
4292, 1953, both disclose such a process. However the prior art processes involve the use of expensive thionyl chloride and chloroform to prepare chloromaltol and zinc and acetic acid reducing means to prepare maltol. As has been mentioned before, this reducing means requires an additional purification step to obtain maltol suitable for food use.

The improved process of the instant invention is distinguished from the Stodola and Shemyakin, et al. process in that relatively inexpensive hydrogen halide reactants may be used and the improved reducing means insures that the maltol ultimately obtained is suitable for use directly in food.

It is accordingly an object of the present invention to provide an improved means for obtaining maltol from gamma-pyrone intermediates.

It is a further object of the present invention to eliminate a purification step usually required to obtain maltol free of chelated iron.

These and other objects may be readily achieved by application of the improved process of the instant invention which comprises treating hydroxymaltol with a reagent selected from the group consisting of hydrogen chloride, hydrogen bromide and hydrogen iodide to form a compound of the formula



wherein X is selected from the group consisting of chloro, bromo and iodo and treating said compound with a reagent selected from the group consisting of hydrosulfurous acid, alkali metal salts of hydrosulfurous acid, alkaline earth metal salts of hydrosulfurous acid, zinc hydrosulfite, ammonium hydrosulfite and hydrogen activated by a noble metal catalyst to form maltol.

Of course, as is well known to those skilled in the art, hydrosulfurous acid ($H_2S_2O_4$, hyposulfurous acid, dithionous acid) is a relatively unstable material. For this reason it is preferred, in the practice of the process of the instant invention, to use this reducing agent in the form of the alkali metal or alkaline earth metal salt derivatives of hydrosulfurous acid, zinc hydrosulfite or ammonium hydrosulfite.

The hydroxymaltol starting material may be readily prepared from commercially-available kojic acid as is described in said copending application, S.N. 171,732.

The preparation of the halomaltol according to the improved process of the present invention may be carried out by the following general procedure: Hydroxymaltol is dissolved in from about 2 to about 6 parts by weight of solvent such as, for example, glacial acetic acid, chloroform, and the like, and the solution is treated with gaseous hydrogen halide. The reaction temperature has a tendency to rise spontaneously within several minutes from 25° C. to about 60° C. While the reaction will go to completion within about 6 to 8 hours if the mixture is maintained at about 60° C. by application of an external heating means, it is preferred to raise the temperature to from about 100° to about 120° C. whereupon the reaction is usually complete in about 1 to 2 hours.

The solvent to be employed in the formation of the halomaltol intermediate is not particularly critical to the invention although it should be relatively inert to the hydrogen halide reactant, and to the halomaltol intermediate, and hydroxymaltol should be at least moderately soluble in said solvent. Particularly effective solvents are acetic acid, formic acid and chloroform. Acetic acid is preferred since it is relatively inexpensive and can be heated to the preferred temperatures at atmospheric pres-

sure; chloroform, having a lower boiling point, can be used in a pressure vessel.

The hydrogen halides may be introduced as gases into the reaction mixture by means well known to the art. It is particularly convenient to minimize losses of reagents especially in large-scale reactions to introduce the hydrogen halide into the reactor under low to moderate pressure, adding hydrogen halide as necessary to replace that which reacts.

It is found that the addition of a small amount of strong acid such as sulfuric or phosphoric to the reaction mixture tends to afford higher yields of chloromaltol when hydrogen chloride is used to treat hydroxymaltol. Amounts of acid of from about 0.1 to about 0.5% by weight of hydroxymaltol are sufficient to achieve this effect, the reason for which is not clearly understood at this time. Such an effect has not been observed when hydrogen bromide or hydrogen iodide are used; nearly quantitative yields of the corresponding halomaltols are obtained in 1–2 hours in the absence of added acid.

The halomaltol is isolated by cooling the reaction mixture from the temperature of the reaction, which is usually about 110–120° C., to about 15–25° C. whereupon the halomaltol crystallizes from solution. The product is removed by filtration and is dried in the air.

With respect to the reduction of the halomaltol to maltol, this can be carried out in good yield by treating a solution of halomaltol with an alkali metal hydrosulfite such as sodium or potassium hydrosulfite, and the like, or with an alkaline earth metal hydrosulfite such as calcium or magnesium hydrosulfite, and the like, or with zinc hydrosulfite or ammonium hydrosulfite. Alternatively, hydrogen gas in the presence of a noble metal catalyst such as finely divided platinum, palladium and platinum oxide or palladium or platinum suspended on supports such as carbon or charcoal, and the like, may be used.

The solvent employed in the reductions employing alkaline hydrosulfite reducing means is not critical to the invention so long as it is relatively inert to the reagents. It is particularly convenient to employ water as a solvent. With the hydrogen activated by a noble metal catalyst reducing means, solvents commonly employed in the art of moderate-pressure catalytic hydrogenation can be used. Especially suitable for this purpose are acetic acid and lower alkanols such as methanol, and the like. Especially preferred because highest yields are obtained in this medium is acetic acid.

The general procedure for reduction of haolmaltol with alkaline hydrosulfites according to the improved process of the present invention is as follows:: About 1.6 moles of the alkaline hydrosulfite is dissolved or suspended in about 10 volumes of water and to this is added about one equivalent or halomaltol during about 30 minutes. During the addition, sufficient 10 N sodium hydroxide solution is added to maintain the pH of the reaction mixture at 5–5.5. At the end of the halomaltol addition, the reaction mixture is stirred for about 30 minutes, then is heated to about 90° C., and a small amount of insoluble material is removed by filtration. Maltol is recovered by cooling the filtrate to about 15° C. whereupon the product precipitates. The crystals are removed by filtration and are dried in air.

With respect to the reduction of halomaltol with hydrogen activated by a noble metal catalyst, the following procedure may be employed:

The halomaltol is suspended in from about 50 to about 200 parts by weight of solvent such as, for example, glacial acetic acid or methanol and to this mixture is added about 2.5% by weight of metal based on the halomaltol of a noble metal catalyst such as, for example, a 5% palladium on carbon catalyst. There is then added an amount of base such as triethylamine or ammonium acetate equivalent to the halomaltol and hydrogen is introduced to the suspension up to an initial pressure of from about 25 to about 100 pounds per square inch. The suspension is shaken and the hydrogen pressure is observed to fall to a nearly constant level, corresponding approximately to the number of equivalents of halomaltol taken within about 15 to about 5 minutes. The maltol can be recovered by filtering the reaction mixture to remove the catalyst and evaporating off the solvent. The maltol which remains as a residue may be further purified by recrystallization from water.

The following examples are illustrative of the improved process of the present invention.

Example I

Hydroxymaltol, 11.36 g., 0.08 mole, is added to 25 ml. of glacial acetic acid in a 50 ml. flash equipped with thermometer, stirrer, gas inlet tube and reflux condenser. Anhydrous hydrogen chloride gas is introduced to the stirred mixture and the temperature is observed to rise from 25° C. to 60° C. within 2 minutes. External heating is applied to increase the temperature to 110° C. and this temperature is maintained while gas is added for an additional 120 minutes. The mixture is allowed to cool to 25° C. and the finely divided solid product which precipitates is removed by filtration. The chloromaltol is extracted from the solid product with about 10 parts by weight of boiling acetone. Evaporation of the extract yields chloromaltol; this is purified by recrystallization from chloroform. There is obtained 2.46 g., M.P., 146–147° C., a 19% yield of theoretical.

The procedure is repeated this time adding 5 drops of concentrated sulfuric acid to the reaction mixture. There is obtained chloromaltol, 9.31 g., M.P., 149–149.2° C., a yield of 74% of theoretical.

Example II

Hydroxymaltol, 28.4 g., 0.2 mole, is added to 62.5 ml. of acetic acid. The stirred mixture is heated in an oil-bath and gaseous hydrogen bromide is added. The mixture becomes homogeneous when the temperature reaches 100° C. and after the temperature reaches 117° C., it is maintained at this temperature for an additional hour. The gas addition is stopped, heating is discontinued and the mixture is allowed to cool to 25° C. The solid material which precipitates is removed by filtration and is dried in a desiccator. There is obtained 32.3 g. of bromomaltol, M.P., 150° C. An additional 6.0 g., M.P., 147–149° C., is obtained by concentration of the filtrate to about one-third volume and filtration of the crystalline precipitate. The solids are combined and recrystallized from about 25 parts by weight of acetic acid. There is obtained a total of 34.7 g. of bromomaltol, a yield of 84.6% of the theoretical, M.P., 170° C.

Example III

The procedure of Example I is repeated substituting anhydrous hydrogen iodide for the corresponding hydrogen chloride. The reaction is carried out in the absence of a sulfuric acid promoter. There is obtained iodomaltol in good yield.

Example IV

Sodium hydrosulfite, 1180 g., is dissolved in 11.4 liters of water then 728 g. of chloromaltol is added gradually during 20 minutes and a total of 408 ml. of 10 N NaOH is added to maintain a pH of 5–5.5. The temperature gradually rises from 24 to 38° C. At the end of the chloromaltol addition, an additional 100 grams of sodium hydrosulfite is added and the mixture is stirred for ½ hour. The suspension then is heated to 91° C. and a small amount of insoluble matter is removed by filtration. The solution is cooled to 15° C. and the maltol which crystallizes, is removed by filtration and is dried in vacuo. Additional maltol is recovered by extracting the aqueous filtrate with four 3.5-liter portions of chloroform. The chloroform extracts are combined and are concentrated under a vacuum of about 200 mm. Hg to yield an additional crop of maltol which is isolated. The combined

total yield of maltol is 70.3% of the theoretical. The first crop product melts at 162–3° C., and is 99% pure by ultraviolet spectrophotometric assay.

The procedure is repeated substituting for the sodium hydrosulfite the following salts: lithium hydrosulfite, potassium hydrosulfite, calcium hydrosulfite, zinc hydrosulfite, magnesium hydrosulfite and ammonium hydrosulfite. Substantially the same results are obtained.

Example V

Chloromaltol, 1.61 g., 0.01 mole, is suspended in 200 ml. of methanol and 3.0 g., of a 5% palladium on carbon catalyst (taken as a 50% suspension in water) and 1.01 g., 1.38 ml., 0.01 mole, of triethylamine are added. The suspension is shaken in a hydrogenation apparatus under a hydrogen atmosphere at an initial pressure of 50 pounds per square inch. The pressure drops to 28.5 pounds per square inch within 30 seconds, then the pressure drop ceases and no further drop in pressure is observed to occur within the next 5 minutes. The reaction mixture is filtered, the filtrate is evaporated to dryness, the residue is suspended in 10 ml. of water, heated until it is dissolved and then the solution is allowed to cool at 5° C. for 12 hours. The crystals which precipitate are removed by filtration, and the filtrate is extracted with 3 volumes of chloroform. The chloroform extracts are evaporated and the crystalline residue is combined with the first precipitate. There is obtained maltol, 0.862 g., a yield of 68.5% of the theoretical, M.P., 159–160° C.

The procedure is repeated substituting glacial acetic acid for methanol. The pressure drops to a constant value within about 2 minutes. There is obtained a total of 1.00 g. of maltol, M.P., 158–160° C., a yield of 79.4% of theory.

Example VI

Bromomaltol, 2.05 g., 0.01 mole, is suspended in 50 ml. of glacial acetic acid and to this are added triethylamine, 1.2 ml., and 2.05 g. of a 5% palladium on carbon catalyst (taken as a 50% aqueous suspension). The suspension is shaken under a hydrogen atmosphere at an initial pressure of 50 pounds per square inch; after 45 minutes the pressure has dropped about 7 pounds per square inch and becomes constant. The mixture is filtered to remove catalyst residue and the solvent is evaporated at a pressure of about 15 mm. of Hg. The residue is dissolved in 10 ml. of hot water and is filtered. The filtrate is allowed to crystallize at 5° C. and the crystals are collected by filtration. There is obtained 0.5814 g. of maltol, M.P., 157–160° C. Extraction of the filtrate with 5 volumes of chloroform and evaporation of the chloroform yields an additional 0.2184 g. of maltol, M.P., 157–160° C. The first crop yield of maltol is 46% of theoretical.

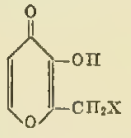
The procedure is repeated substituting the folowing catalysts for palladium on carbon on an equal weight based on the metal basis: platinum black, palladium black, platinic oxide, and platinum on carbon. Substantially the same results are obtained.

Example VII

The procedure of Example IV is repeated substituting iodomaltol for chloromaltol on an equimolar basis. Maltol is isolated in good yield.

What is claimed is:

1. An improved process for the preparation of maltol from hydroxymaltol which comprises treating hydroxymaltol with a reagent selected from the group consisting of hydrogen chloride, hydrogen bromide and hydrogen iodide to form a compound of the formula



wherein X is selected from the group consisting of chloro, bromo and iodo and treating said compound with a reducing agent selected from the group consisting of alkali metal salts of hydrosulfurous acid, alkaline earth metal salts of hydrosulfurous acid, zinc hydrosulfite, ammonium hydrosulfite and hydrogen activated by a noble metal catalyst to form maltol.

2. A process as in claim 1 wherein said substituent X is chloro.

3. A process as in claim 1 wherein said substituent X is bromo.

4. A process as in claim 1 wherein said reducing agent is sodium hydrosulfite.

5. A process as in claim 1 wherein said noble metal catalyst is palladium.

6. An improved process for the preparation of maltol from hydroxymaltol which comprises treating hydroxymaltol with hydrogen chloride to form chloromaltol and treating said chloromaltol with sodium hydrosulfite to form maltol.

7. A process which comprises treating chloromaltol with sodium hydrosulfite to form maltol.

No references cited.

Maltol + Monosodium glutamate

United States Patent Office 3,156,569
Patented Nov. 10, 1964

3,156,569

SEASONING COMPOSITION AND METHOD OF ENHANCING THE FLAVOR OF FOODS CONTAINING A GLUTAMIC ACID SALT

Joan M. Griffin, Forest Hills, and Edward F. Bouchard, Huntington, N.Y., and Kurt S. Konigsbacher, Stamford, Conn., assignors to Chas. Pfizer & Co., Inc., New York, N.Y., a corporation of Delaware

No Drawing. Filed Feb. 1, 1962, Ser. No. 170,494
13 Claims. (Cl. 99—140)

This invention relates to enhancing the flavor of foods. More particularly, it is concerned with new and novel seasoning compositions, with food products containing said novel compositions and with improved methods for enhancing the flavor and aroma of food products.

It is a matter of common knowledge and experience that the addition of monosodium glutamate and other commercially available glutamic acid salts such as, for example, monopotassium glutamate and monocalcium diglutamate, and the like, to many foods improves the flavor thereof to such an extent that wide consumer acceptance of the practice has been obtained. This appreciation of improved flavor is reflected in increased sales volume of food so treated. Furthermore, numerous taste panel tests demonstrate that many foods containing monosodium glutamate and its related salts are preferred over those from which it is omitted. This acceptance has been found for glutamate-treated meats, poultry, fish and shellfish, vegetables, soups, soup mixes, certain types of cheese spreads, breading mixes, sauces and salad dressings. In addition to their effect on fresh foods, said glutamates heighten the gustatory appeal of canned or frozen foods as well as of meats cured by pickling and smoking.

It has now been surprisingly found that an unexpected increase in flavor and odor enhancement and appreciation is obtained if controlled amounts of maltol (3-hydroxy-2-methyl-4-pyrone) are used with glutamates to season foods. This unexpected enhancement in characteristic and desirable odor and flavor is particularly pronounced in soups, meats, fish and vegetables. Furthermore, these valuable manifestations arise only when the unique combinations of the instant invention are employed and are not observed when glutamates or maltol are used independently.

Maltol as a chemical entity is a white crystalline material with a sweet odor and characteristic taste. This combination of properties has been made use of in the past by adding maltol to such foods as cakes, candies, chocolate fillings, desserts, cookies, beverages and fruit salads, juices and wines. The effect of such additions has been to increase the impression of sweetness already present in the food while providing a gain in the "body" of the flavor.

Monosodium glutamate as a chemical entity is a white, crystalline material with a characteristic sweet-saline taste and no odor. Monosodium glutamate and the other said glutamates have the specific properties of increasing salivary secretion, imparting a sensation of increased succulence to food and contributing to the persistence of the taste sensation. These effects are most marked when the glutamates are added to foods such as soups, meats, fish and vegetables.

As will be exemplified in detail hereinafter, the unusual enhancement of aroma and flavor of foods obtained by application of this invention is observed following the use of seasoning mixtures containing said glutamates and maltol, wherein the maltol is present in said mixture in an amount of from about 0.5 to about 20 percent by weight based on the glutamate. In addition, the effective levels of usage of such seasoning mixtures as contemplated by the present invention are found to range

from about 0.05 to about 1.0 percent by weight of the prepared food.

It is to be understood that the present invention is not limited to the single embodiment of mixtures of glutamates and maltol but contemplates moreover the further embodiments comprising processes involving, and products made by, the addition of these two materials to food as a single substance and in any order of addition. Furthermore, it is to be understood that this invention can be advantageously used in combination with many other seasonings ordinarily used in the preparation of food. Among said seasonings are salt, pepper, cloves, cinnamon, nutmeg, and the like.

A particularly desirable embodiment of the instant invention is the use of a combination of maltol, a glutamate and inosinic acid or the sodium, potassium and calcium salts thereof. Thus, as will be exemplified hereinafter, a combination of maltol, monosodium glutamate and inosinate salts has been found to be particularly effective in increasing the appeal of beef-containing foods. The inosinic acid or salt thereof may be employed in amounts equivalent to up to about 20 percent by weight of the glutamate. However, for most purposes it is preferred to use inosinic acid at levels of from about 6 to about 12 percent by weight of the glutamate.

It is accordingly among the objects of the present invention to provide seasoning compositions with improved flavor enhancing effects when used in foods. A further object is to provide food preparations with much enhanced flavor and aroma and therefore wider acceptability. A further object is to provide improved methods for the enhancement of flavor and aroma of prepared foods.

These and other objects are achieved by application of the process of this invention which in essence comprises enhancing the flavor and aroma of prepared food by incorporating therein an amount of up to about 1 percent by weight of a glutamic acid salt and maltol, said maltol being present in the amount of from about 0.5 to about 20 percent by weight of said glutamic acid salt.

The glutamic acid salt employed can have as its cation component any of the species which are acceptable for use in the flavor enhancement art. Particularly preferred for the practice of this invention are the cations, sodium, potassium and calcium. Potassium and calcium are used in cases where dietary needs require low sodium intake.

The total amount of seasoning mixtures to be used will be determined by the nature of the food to be so-treated. The native flavor of the food is one important factor. Highly-spiced or strongly-flavored foods usually require less of the composition than blander foods. Another factor in the level to be used is the subjective taste sensitivity of the consumer. However, with certain exceptions for rare individual tastes, the preferred concentrations set out hereinafter are subjectively approved by the great majority of consumers. Accordingly, while the composition can be employed in the range from about 0.05 to about 1 percent by weight it is usually preferable to use amounts ranging from about 0.1 to about 0.3 percent by weight in normally salted food.

In terms of the preferences of subjects in taste and aroma test panels, the amount of maltol to be used with glutamate salts is critical to the present invention. If the amount of maltol is increased to above about 20 percent by weight of the glutamate salt, it is found that an unpleasant "burning" sensation may be noticed when tasting foods containing normally effective amounts, that is, between about 0.05 and 1 percent of total seasoning. If, on the other hand, the amount of maltol in the compositions is decreased to below about 0.5 percent by weight of

the glutamate salt and foods are prepared containing the aforesaid normally effective amounts of seasoning, it is found that the unusual flavor enhancement which is one of the objects of this invention cannot be detected by normal subjects. The amount of maltol to be used with glutamates within these aforesaid limits of about 0.5 to about 20 percent by weight of the glutamate is determined by the nature of the food to be treated. It is found, for example, that a preferred level of maltol to be used with glutamates to flavor beef bouillon is about 8 percent by weight, to flavor clam chowder a preferred level is about 8 to about 19 percent by weight, to flavor a vegetable cream soup a preferred level is about 6 to about 10 percent by weight, to flavor spaghetti with meatballs a preferred level is about 8 percent by weight and to flavor chicken pies a preferred level is about 10 percent by weight of the glutamate.

The method of adding the seasonings to food is not critical to the invention. Addition of the compositions is easily accomplished in most food processing operations. They can be added in a separate step, but in many operations it is preferred as a manner of convenience to add them in conjunction with spices, sugar or salt, either in a dry mix or in solution. This method is particularly applicable for the preparation of canned soups, stews, sauces, chili and batch-type canned or precooked frozen food products. For cured, primal cuts of meat, the mixtures can be added to the pumping pickle after first dissolving it in water.

In the preparations of vegtables for freezing, the novel seasoning compositions of the instant invention can be added just after blanching either in powder forms or in solution. If the seasonings are added as powders, it is preferred to allow a few minutes to elapse before the packages are placed in the freezer. In canning vegetables, the composition is added just before filling. Among the vegetables for which the flavor and aroma are found to be markedly enhanced by treatment with the valuable compositions of this invention or with their components individually are: asparagus, broccoli, Brussels sprouts, carrots, cauliflower, creamed corn, whole corn, green beans, lima beans, mixed vegetables, mushrooms, peas, potatoes, spinach, tomatoes, and the like.

For addition to meats, the usual dspensers for dry salt can be used for the compositions and their individual components of this invention. While not necessary, it is sometimes preferred to rub the seasoning compositions into the surface of the meat. Liquid dispensers may also be employed to add solutions of the aforesaid compositions to meat. In treating fresh comminuted meats, the compositions of this invention may be mixed with other seasonings or, alternatively, they may be scattered on the meat before grinding or after the first rough grind. For cured comminuted meats, the compositions or their individual components may be added to the chop with other seasoning components. For cured primal cuts it can be added to the pumping pickle. In the case of breaded products, the compositions are conveniently added to the breading mix. Among the meat products for which a marked enhancement of flavor and odor are obtained by the treatment of this invention are: canned or frozen beef, veal, lamb and pork; pork sausage, liver sausage, frankfurters and bologna; hamburger; hams, bacon, pork shoulder, pork butt; meat loaves and spreads; frozen meat pies; chip steaks, canned meatballs and spaghetti, canned corn beef hash; canned chili, canned stews, canned meat and gravy, canned luncheon meats; and the like.

The compositions of the present invention or their individual components are conveniently applied to poultry by sprinkling into the body cavity of whole birds. If the birds are cooled in an ice bath, it is preferred that the application be made after cooling. It is generally not effective to apply the compositions to the skin. Cut parts can be dusted with the compositions or sprinkled with water solutions thereof. Among the poultry products which exhibit a marked enhancement of flavor and aroma after treatment are: fresh or frozen dressed poultry, canned whole chicken with butter sauce, canned whole chicken with plain broth, canned boned chicken, canned boned turkey, canned chicken fricassee, concentrated chicken broth, canned or frozen chicken a la king, frozen chicken and turkey pies, and the like.

The compositions of the present invention or their individual components may be applied to seafoods together with other seasoning agents or may be applied as a powder or spray. It is preferred that application be made to both sides of fish which should stand 10 to 15 minutes before freezing. Among the seafoods which exhibit a marked enhancement of flavor and aroma after the treatment of the present invention are: canned or frozen fish, fish fillets and steaks, shrimp, scallops, oysters, crab, canned sardines, canned salmon, canned tuna, frozen tuna pies, canned fish pastes, frozen breaded seafood, and the like.

In addition, other food products in which the flavor and aroma are enhanced by treatment with the compositions of the persent invention are: concentrated canned soups, ready-to-serve canned soups, dehydrated soups, cheese crackers, popcorn, potato chips, spice blends, bouillon cubes and pastes, mayonnaise, French and Russian dressings, and the like.

Of course, as has been mentioned hereinbefore, the maltol need not be added to food at the same time that glutamates are added. It may be more convenient in some cases, for example, to add maltol before or after the glutamates.

The following specific examples illustrate the practice of the invention, but are not to be construed as limiting the invention to the foods specifically disclosed.

Example I

Various amounts of monosodium glutamate and maltol are added to a commercial concentrated clam chowder. The chowder is diluted with an equal volume of water and is cooked according to the manufacturer's directions. The aroma is determined during the cooking step and after it is cooled to serving temperature the chowder is tasted. The results are tabulated below:

Monosodium Glutamate, Concentration, Percent of Weight of Concentrated Clam Chowder	Maltol, Concentration, Percent of Monosodium Glutamate	Aroma, Hot	Flavor, Warm
0 (control)	0 (control)		
0.125	0	No change over control	More succulent than control.
0.125	1.7	Slight increase in body	Do.
0.125	2.8	More body than control	Do.
0.125	7.4	Very pleasing body	Much more succulent than control.
0.125	16.7	do	Very much more succulent than control.
0.125	28.4	Cloyingly sweet	Strong burning sensation.

Thus it is observed that at levels corresponding to 7.4 and 16.7 percent of the total added monosodium glutamate, maltol induces a much enhanced flavor and aroma to clam chowder.

The procedure is repeated, substituting for the monosodium glutamate an equal weight of monopotassium

glutamate; substantially the same results are obtained. The procedure is repeated substituting for the monosodium glutamate an equal weight of monocalcium diglutamate. Substantially the same results are obtained.

Example II

To a commercial dehydrated meat and vegetable soup mix is added various amounts of maltol, glutamic acid salts and sodium inosinate. The mixes are reconstituted with water and the soup is prepared according to the manufacturer's directions. The aroma is determined during the cooking step and after the soup is cooled to serving temperature it is tasted. The results are tabulated below:

Glutamic Acid Salt Concentration, Percent of Weight of Reconstituted Soup	Concentration, Percent of Glutamic Acid Salt		Aroma, Hot	Flavor, Warm
	Maltol	Sodium Inosinate		
Monosodium Glutamate:				
0 (control)	0 (control)	0 (control)		
0.1	1.0	0	More meaty than control	Slightly more succulent than control.
0.1	10.0	0	Much more meaty than control.	Do.
0.1	20.0	0	do	Do.
0.7	1.0	0	More meaty than control	Much more succulent than control.
0.7	10.0	0	Much more meaty than control.	Do.
0.7	20.0	0	do	Do.
0.7	1.0	1.0	More meaty than control	Slightly more succulent than control.
0.7	10.0	10.0	Much more meaty than control.	Much more succulent and "beefy" than control.
0.7	20.0	20.0	do	Do.
0.7	25.0	25.0	Cloyingly sweet	Salty; tendency toward burning sensation.
0.7	0	10	No change over control	More succulent and "beefy" than control.
Monopotassium Glutamate:				
0.7	10.0	0	Much more meaty than control.	Much more succulent than control.
0.7	10.0	10.0	do	Much more succulent and "beefy" than control.
0.7	10.0	25.0	do	Tendency toward salty taste.
Monocalcium Diglutamate:				
0.7	10.0	0	do	Much more succulent than control.
0.7	10.0	10.0	do	Much more succulent and "beefy" than control.
0.7	10.0	25.0	do	Tendency toward salty taste.
0.7	0	20.0	No change over control	Murch more succulent and "beefy" than control.

The procedure is repeated substituting respectively inosinic acid, potassium inosinate and calcium inosinate for sodium inosinate; substantially the same results are obtained.

The addition of maltol in amounts of up to about 20 percent by weight of monosodium, monopotassium and monocalcium glutamate is found to enhance the aroma and taste of the soup. The addition of inosinic acid and the sodium, potassium and calcium salts thereof in amounts of up to about 20 percent by weight of glutamic acid salts is found to increase the natural "beefy" flavor of the soup. This "beefy" flavor is less enhanced in the absence of maltol.

Example III

Various amounts of maltol and monosodium glutamate are dissolved in water and added to the gravy in a commercial frozen meat pie filling. The filling is turned into individual pie shells and the pies are baked according to the directions supplied by the manufacturer. While still hot the crusts are cut and the aroma is carefully determined; when cooled to eating temperature, the flavor of the pies are compared by a taste panel. The results are tabulated below:

Monosodium Glutamate, Concentration, Percent of Weight of Pie Filling	Maltol Concentration, Percent of Monosodium Glutamate	Aroma, Hot	Flavor, Warm
0 (control)	0 (control)		
0.2	0	No change over control	More succulent than control.
0.2	2.4	Slightly more meaty than control.	Do.
0.2	4.75	More meaty than control	Much more succulent than control.
0.2	11.1	Much more meaty than control.	Do.
0.2	21.0	Somewhat fruity aroma	Slight burning sensation.

Thus it is seen that 4.75 and 11.1 percent of maltol appreciably increase the succulence and meaty aroma of the food.

The monosodium glutamate concentration is increased from 0.2 percent to 1.0 percent of the pie filling. In the absence of maltol it is observed that the succulence of the product is increased only very slightly and there is no change in the aroma of this product compared to that of the control. In the absence of monosodium glutamate the effect of addition of maltol at corresponding levels of 50, 100, 250 and 500 mg./kg. of pie filling mixture is to provide an enhanced aroma at the two intermediate levels. No appreciable enhancement of the meaty flavor is obtained.

Example IV

Various blends of crystalline monosodium glutamate and maltol are made. These are added by means of a shaking type dispenser to the surface of chopped sirloin beef steaks very shortly before the end of a brief broiling period. At the end of the broiling period the steaks are removed to a hot dish and the aroma is determined.

After cooling to serving temperature the steaks are tasted. The results are tabulated below:

Monosodium Glutamate, Concentration, Percent of Weight of Chopped Sirloin Beef Steak	Maltol, Concentration, Percent of Monosodium Glutamate	Aroma, Hot	Flavor, Warm
0 (control)	0 (control)		
0.05	0	No change over control	Slightly more succulent than control.
0.05	0.5	More meaty than control	More succulent than control.
0.10	0.5	do	Do.
0.30	0.5	do	Much more succulent than control.
1.0	0.5	do	Much more succulent than control; somewhat salty.
0.05	10	Much more meaty than control.	More succulent than control.
0.05	20	Tendency toward sweetness	Tendency toward burning sensation.
0.2	10	Much more meaty than control.	Much more succulent than control.
0.3	10	do	Very much more succulent than control.
0.6	10	do	Do.
1.0	10	do	Slightly salty.
1.0	20	do	Do.
1.0	21	Tendency toward sweetness	Tendency toward burning sensation.
1.0	25	Fruity	Burning sensation.

The procedure of this example is repeated except that maltol and the glutamic acid salts are added individually to the ground steak mix before it is cooked; substantially the same results are obtained. The procedure is repeated incorporating the glutamic acid salt into the ground meat before cooking and adding the maltol very shortly before the end of the broiling period; substantially the same results are obtained. The procedure is repeated incorporating the maltol in the ground meat before cooking and adding the monosodium glutamate shortly before the end of the broiling period; substantially the same results are obtained.

Example V

Fresh shelled green peas are suspended in enough water to cover. To the liquor are added various amounts of monosodium glutamate and maltol. The preparations are allowed to stand for 10 minutes, then are simmered for 15 minutes and the aroma is determined during cooking. The peas are drained and after cooling to serving temperature are tasted. The results are tabulated below:

Monosodium Glutamate, Concentration, Percent of Weight of Fresh Green Peas	Maltol, Concentration, Percent of Monosodium Glutamate	Aroma, Hot	Flavor, Warm
0 (control)	0 (control)		
0.265	0	No change over control	Slightly brighter than control.
0.265	3.64	Fresh garden odor enhanced	Much brighter, freshly-picked flavor.
0.265	8.60	Somewhat sweeter than control.	Much brighter, fresh-picked flavor.
0.265	15.8	do	Much brighter, freshly-picked flavor.

The addition of maltol to peas containing monosodium glutamate is found to markedly increase the freshly-picked natural flavor of the vegetable and to provide a very acceptable increase in aroma.

The procedure is repeated substituting whole kernel corn for the green peas. Substantially the same results are obtained.

The foregoing examples have illustrated the manner in which the flavor and aroma of foods are enhanced by the addition of maltol to foods containing from about 0.05 to about 1.0 percent by weight of glutamic acid salts. This effect has been obtained through use of amounts of maltol from about 0.5 to about 20 percent based on the glutamic acid salts. Outside of the range there was observed an induced sweetness or fruitiness in the aroma and a burning sensation in the taste above the upper limit and no appreciable enhancing effect on either aroma or flavor below the lower limit. In no case within the stated limits was the food altered in an undesirable sense by the treatment.

What is claimed is:

1. A seasoning for food which comprises a mixture of a glutamic acid salt and maltol, said mixture containing maltol in an amount of from about 0.5 to about 20 percent by weight of the said glutamic acid salt.

2. A composition as in claim 1 wherein the said glutamic acid salt is monosodium glutamate.

3. A composition as in claim 1 wherein the said glutamic acid salt is monopotassium glutamate.

4. A composition as in claim 1 wherein the said glutamic acid salt is monocalcium diglutamate.

5. A prepared food containing therein from about 0.05 to about 1 percent of its weight of a glutamic acid salt and maltol in an amount of from about 0.5 to about 20 percent by weight of the said glutamic acid salt.

6. A prepared food as in claim 5 wherein the said glutamic acid salt is monosodium glutamate.

7. A prepared food as in claim 5 wherein the said glutamic acid salt is monopotassium glutamate.

8. A prepared food as in claim 5 wherein the said glutamic acid salt is monocalcium diglutamate.

9. A prepared food as in claim 5 wherein a compound selected from the group consisting of inosinic acid, sodium inosinate, potassium inosinate and calcium inosinate is added in an amount of from about 0.5 to about 20 percent by weight of the said glutamic acid salt.

10. In the method for imparting enhanced flavor to foods by adding thereto a glutamic acid salt, the improvement which comprises adding thereto maltol in the amount of from about 0.5 to about 20 percent by weight of the said glutamic acid salt.

11. A method as in claim 10 wherein the said glutamic acid salt is monosodium glutamate.

12. A method as in claim 10 wherein the said glutamic acid salt is monopotassium glutamate.

13. A method as in claim 10 wherein the said glutamic acid salt is monocalcium diglutamate.

References Cited in the file of this patent

UNITED STATES PATENTS

1,035,591	Ikeda et al.	Aug. 13, 1912
2,283,589	Stuart	May 19, 1942
2,512,385	Sabine	June 20, 1950

2,790,719	Glickman	Apr. 30, 1957
2,920,965	Ziegler et al.	Jan. 12, 1960

OTHER REFERENCES

"The Chemical Senses," by Moncrieff, Leonard Hill Limited, 17 Stratford Place, W.L., London, 1944, page 197.

"The Merck Index," sixth edition, published by Merck & Co., Inc., Rahway, N.J., 1952, page 596.

United States Patent Office

3,159,652

Patented Dec. 1, 1964

3,159,652

PREPARATION OF GAMMA-PYRONES

Bryce E. Tate, Niantic, and Robert P. Allingham, Groton, Conn., assignors to Chas. Pfizer & Co., Inc., New York, N.Y., a corporation of Delaware

No Drawing. Filed June 13, 1962, Ser. No. 202,101

11 Claims. (Cl. 260—345.9)

This invention relates to new and useful gamma-pyrones and to processes for their preparation. More particularly, it is concerned with valuable intermediates useful in the preparation of maltol, a valuable gamma-pyrone, which is employed, for example, to impart enhanced flavor and aroma to a variety of foods. The present invention is also concerned with novel processes employing these intermediates in the synthesis of maltol.

As is disclosed in the copending application of B. E. Tate and R. L. Miller, S.N. 171,732, filed February 7, 1962, and now Patent No. 3,130,204, assigned to the assignee of the present application, it is now possible to prepare maltol from a readily available and economical gamma-pyrone, kojic acid, by a series of chemical transformations.

The process of the said copending application involves the oxidation of kojic acid to comenic acid, the decarboxylation thereof to form pyromeconic acid, hydroxymethylation thereof to form hydroxymaltol and reduction thereof to form maltol.

While the process therein disclosed produces maltol of good quality, in good yield, it is necessary as a final step to distill the maltol to obtain a product of highest purity and freedom from color.

It has now been found by the practice of this invention that it is possible to eliminate a distillation step and to combine the final distillation step with a decarboxylation step thus obtaning maltol of excellent purity and color more economically. These novel syntheses of maltol from the intermediates contemplated by the instant invention involve, in their final steps, the decarboxylation of 6-methylcomenic acid or the 2,3-dihydro-derivative thereof.

It is also found if maltol is made from 6-methylcomenic acid, one of the valuable new gamma-pyrones of the instant invention, that the choice of solvents for the decarboxylation step is much broader owing to its higher solubility compared to the corresponding comenic acid employed in the said copending application.

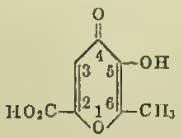
It is accordingly an object of this invention to prepare maltol from kojic acid whereby an expensive and yield-consuming distillation step is eliminated.

A further object of this invention is to provide an improved means to prepare maltol from kojic acid whereby the previous choice of decarboxylation solvents is broadened.

A still further object of this invention is to prepare new and valuable gamma-pyrone compounds among which are 6-methylcomenic acid, 6-methylkojic acid and 2,3-dihydro-6-methylcomenic acid.

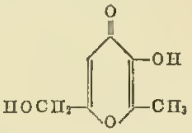
These and other objects of the present invention will be apparent to those skilled in the art from the following description.

One of the new compounds of the present invention is 6-methylcomenic acid, a compound of the formula



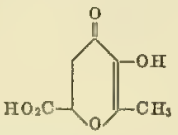
This valuable new crystalline compound has a melting point of 237.5–238.0° C.

The instant invention also contemplates 6-methylkojic acid, a compound of the formula



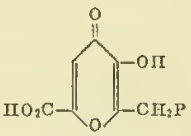
This valuable new crystalline compound has a melting point of 145–145.5° C.

Furthermore, the instant invention contemplates 2,3-dihydro-6-methylcomenic acid, a compound of the formula



This valuable new crystalline compound has a melting point of 156–157° C.

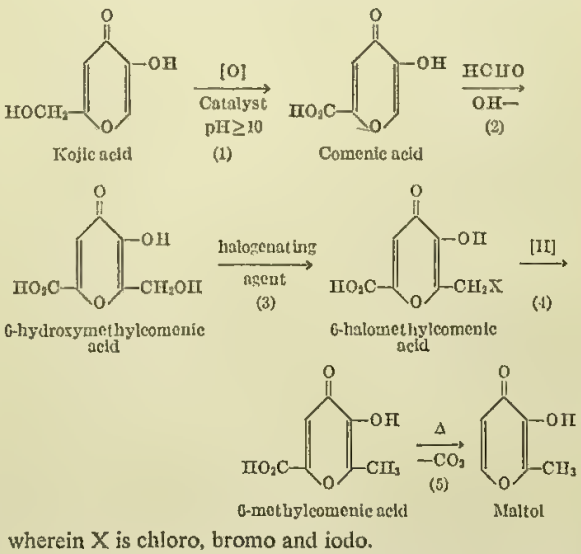
In addition, the instant invention contemplates novel gamma-pyrones of the formula



wherein P is selected from the group consisting of hydroxyl, di-lower alkylamino, said lower alkyl groups containing from one to about four carbon atoms, piperidino, morpholino, chloro, bromo and iodo.

Still another valuable gamma-pyrone contemplated by the instant invention is di-n-butylaminomethylkojic acid.

These valuable intermediates and maltol may be readily obtained from kojic acid according to the routes outlined in the following sequence and other reactions to be detailed hereinafter:



wherein X is chloro, bromo and iodo.

The first step in the sequence is carried out by the improved process of the aforesaid copending application which comprises adding oxygen to an aqueous solution of kojic acid adjusted to a pH of at least about 10 in the presence of a noble metal catalyst.

The second step in the sequence, conversion of comenic acid to the new compound 6-hydroxymethylcomenic acid, can be carried out by suspending comenic acid in from about 3 to about 10 parts by weight of water, adjusting the pH to about 10 by adding 50 wt. percent aqueous base

such as, for example, sodium hydroxide, adding one mole equivalent of formaldehyde thereto, and keeping the resulting solution at a temperature of from about 15 to about 60° C. for from about 30 minutes to about 5 hours. The hydroxymethylcomenic acid can be isolated by adjusting the pH of the reaction mixture to below about 5 by adding aqueous acid, for example, 12 N hydrochloric acid. It is preferred to reduce the pH to below about 1 to minimize a tendency for the corresponding sodium salt to coprecipitate. The resulting slurry can be cooled to about 5° C., and the precipitated product can be removed by filtration. Concentration of the filtrate to about ⅕ volume affords an additional crop of 6-hydroxymethylcomenic acid. The combined yield of product is of the order of 90–95 percent of theoretical.

While it is to be understood that the present invention contemplates the direct conversion of 6-hydroxymethylcomenic acid to 6-methylcomenic acid by treatment with hydrogen in the presence of a noble metal catalyst in glacial acetic acid, or with chemical reducing agents such as, for example, sodium hydrosulfite, higher yields of 6-methylcomenic acid are obtained if the hydroxymethylcomenic acid is first converted to the corresponding halomethylcomenic acid and this intermediate is subsequently reduced. For the direct conversion of 6-hydroxymethylcomenic acid to 6-methylcomenic acid, suitable noble metal catalysts are, for example, palladium and platinum, employed in the form of the finely divided metals or suspended on supports such as carbon, charcoal, and the like. The reduction solvent is somewhat critical in this instance, glacial acetic acid affords highest yields, methanol somewhat less and in water, at pH 11, no reduction occurs at all.

With reference to Step (3) of the reaction process outlined hereinbefore, the 6-halomethylcomenic acid can be prepared by treatment of 6-hydroxymethylcomenic acid with halogen acid, for example, hydrogen bromide, hydrogen chloride or hydrogen iodide. An especially convenient procedure for the preparation of 6-bromomethylcomenic acid comprises treating a suspension of hydroxymethylcomenic acid in from about 3 to about 10 parts by weight of glacial acetic acid with dry hydrogen bromide gas. The gas is passed rapidly into the suspension whereupon the mixture spontaneously heats up to about 55–60° C. in about 15 minutes. Sufficient external heat is then applied to cause the temperature to rise 90 to 110° C. while the gas is introduced. The reaction is maintained under these conditions for an additional 1.5–2 hours, then is cooled to about 25° C. A small amount of sodium bromide by-product is removed by filtration and the solvent is concentrated at a pressure of about 20 mm. Hg to about ¾ of the original volume. The product, 6-bromomethylcomenic acid, can be isolated by filtration and can be further purified by recrystallization from an organic solvent such as, for example, ethyl acetate, acetic acid, and the like. There is obtained in yields corresponding to up to 90% of theory, 6-bromomethylcomenic acid, M.P. 197–197.5° C.

The preparation of 6-chloromethylcomenic acid is carried out in the same manner substituting gaseous hydrogen chloride for the corresponding hydrogen bromide. It is found in this case, however, that the yields tend to be lower unless about 5% by weight, based on hydroxymethylcomenic acid, of a strong mineral acid such as sulfuric or phosphoric acid is added.

With respect to Step (4), the reduction of 6-halomethylcomenic acid to 6-methylcomenic acid, this reaction can be carried out, for example, in the presence of chemical reducing agents such as sodium, potassium, lithium, calcium, magnesium, zinc and ammonium hydrosulfites or with hydrogen activated by noble metal catalysts such as, for example, platinum and palladium either in the form of the finely divided metals or supported on carbon or charcoal, and the like, or with a metal-acid reducing agent combination. It is especially preferred to use sodium hydrosulfite because this reagent is economical and readily available. For example, a solution of sodium hydrosulfite in from about 5 to about 10 parts per weight of water is adjusted to a pH of about 5.0–5.5 by the addition of a small amount of 1 N hydrochloric acid. To this is then added portionwise during about 15 minutes, about 0.66 molar equivalents of 6-bromomethylcomenic acid based on sodium hydrosulfite, and sufficient 1 N sodium hydroxide solution to maintain the pH, which tends to fall, at 5.0–5.5. The temperature of the mixture tends to spontaneously rise to about 40° C. To complete the reaction, the mixture is stirred for about one hour, then is heated to about 60° C. and is stirred for an additional 2 hours. Paper chromatographic analysis indicates that substantially all of the 6-bromomethylcomenic acid has been reduced after this time. 6-methylcomenic acid can be isolated by adjusting the pH of the reaction mixture to about 1 by addition of concentrated hydrochloric acid and, after a small amount of sulfur is filtered off and the filtrate is cooled to about 5° C., crystals of the acid precipitate. After filtration there is obtained 6-methylcomenic acid in excellent yield.

It is to be understood that by the term metal-acid reducing agent combinations as used herein and in the appended claims it is meant, as is obvious to those skilled in the art, combinations of acids with metals appropriately located in the electromotive series of the elements, which combinations provide a reducing action on compounds. As is mentioned in this sequence and those to be discussed subsequently, and as will be exemplified hereinafter, the term metal-acid reducing agent combinations contemplates as metals, for example, zinc, iron, aluminum, tin, magnesium, and the like, and as acids, strong mineral acids such as, for example, hydrochloric acid and sulfuric acid and monocarboxylic saturated, open-chain aliphatic acids that have from 1 to 10 carbon atoms and which are soluble in the reaction system, such organic acids being represented by, for example formic acid, acetic acid, isodecanoic acid and the like.

An alternative method for the reduction of 6-bromomethylcomenic acid comprises dissolving the compound in about 10 volumes of glacial acetic acid, adding a 5 percent palladium on carbon hydrogenation catalyst in an amount corresponding to about one percent by weight of palladium based on the 6-bromomethylcomenic acid and treating with hydrogen in a pressure apparatus until the theoretical amount has been absorbed. It is quite suitable and convenient to carry out this reaction at a pressure of about 50 p.s.i. of hydrogen. The product can be isolated by removing the catalyst by filtration, evaporating the solvent and recrystallizing the residue from ethyl acetate. By this procedure 6-methylcomenic acid is obtained in yields of up to about 90% of the theoretical.

Although both 6-iodo- and 6-chloromethylcomenic acids can be reduced to 6-methylcomenic acid according to the methods described, the yields tend to be lower and the product tends to be somewhat more difficult to isolate, than in the case of the 6-bromo compound; accordingly, it is preferred to employ the bromo compound.

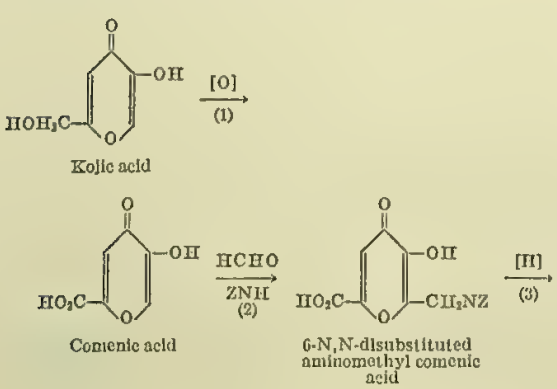
With respect to Step (5), the decarboxylation of 6-methylcomenic acid to maltol, the improved process of said copending application may be employed substituting 6-methylcomenic acid for the comenic acid employed therein. For example, 6-methylcomenic acid can be suspended in from about 2 to about 5 parts by weight of decarboxylation solvent, for example, dimethyl phthalate, dibutyl carbitol, α-methylnaphthalene, and the like. The suspension is then stirred and heated; it is found that the comenic acid is almost completely in solution when the temperature reaches about 150° C. A vigorous evolution of carbon dioxide is observed when the temperature reaches about 220° C. The temperature is gradually increased to 250° C. over a period of about 20 to 25 minutes whereupon carbon dioxide evolution substantially ceases. To isolate the product, the reaction mixture can

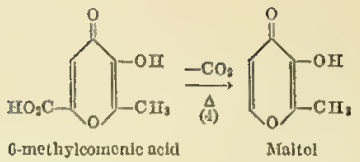
be cooled to 100° C., a vacuum corresponding to about 15 mm. of Hg is applied and the reaction mixture is heated to a temperature of from about 150 to about 250° C. whereupon maltol distills from the vessel at a vapor temperature of about 140–150° C. The distillate, which usually contains some decarboxylation solvent, is cooled and the maltol which crystallizes is removed by filtration and can be freed of solvent by washing with about 5 volumes of cold ethyl acetate. There is obtained maltol, in a yield corresponding to about 75% of theory, M.P. 157–160° C., eminently suitable for use as a flavor and aroma enhancer.

Alternatively, the 6-hydroxymethylcomenic acid can be treated with a metal-acid reducing agent combination and maltol can be prepared by an oxidative decarboxylation of the new intermediate formed thereby. This said intermediate, 2,3-dihydro-6-methylcomenic acid, is contemplated by the instant invention.

A convenient procedure comprises treating a mixture of hydroxymethylcomenic acid and about 2 molar equivalents of zinc suspended in about 5 parts by weight, based on the acid, of water with about 4 molar equivalents of concentrated hydrochloric acid. The mixture is stirred at about 60° C. for about one hour then the unreacted zinc is removed by filtration. An amount of oxalic acid solution equivalent to about 0.9 molar equivalent of zinc originally taken is added and the zinc oxalate which precipitates is removed by filtation. The filtrate is adjusted to a pH of about 1 by adding 50% aqueous sodium hydroxide solution and the solvent is evaporated in vacuo. The product can be isolated by extracting the residue with a small volume of glacial acetic acid and filtering off the insoluble organic salts after which the acetic acid is evaporated in vacuo and the residue is recrystallized from ethyl acetate. The 2,3-dihydro-6-methylcomenic acid is oxidatively decarboxylated to form maltol by dissolving the crystalline material in about 30 parts by weight of glacial acetic acid and adding an equimolar amount of lead tetraacetate. The temperature of the mixture spontaneously rises to about 30° C. and after an hour at 25–30° C., maltol is indicated by paper chromatography to be present in the reaction mixture. The reaction is taken to completion by heating the mixture for one hour at 40° C., for an additional hour at 60° C. and finally for an additional hour at reflux temperatures. The maltol is isolated in 70% yield by cooling the reaction mixture to 25° C., diluting with an equal volume of water and extracting the mixture once with an equal volume of chloroform and once with an equal volume of ether and finally evaporating the combined organic extracts. It can be further purified by recrystallization from hot water.

Another process for the preparation of the valuable gamma-pyrones of the instant invention involves the so-called Mannich intermediates. Thus, maltol can be prepared from kojic acid via another of the new intermediates contemplated by the instant invention, 6-N,N-disubstituted-aminomethylcomenic acid. This process is represented by the following reaction sequence:





wherein ZN is selected from the group consisting of di-lower alkylamino, said alkyl groups containing up to about 4 carbon atoms, piperidino and morpholino.

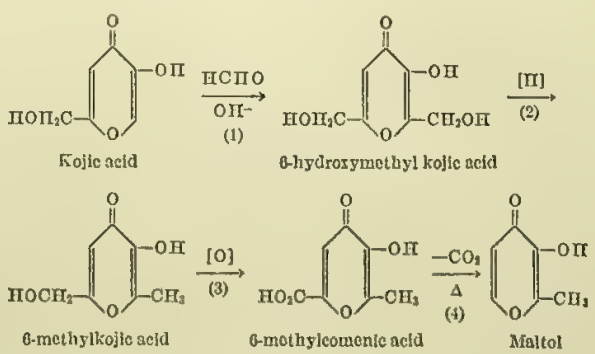
Step (1) of the sequence, the oxidation of kojic acid to comenic acid, is carried out by the process described in said copending application.

Step (2) of the reaction sequence, the conversion of comenic acid to the corresponding Mannich derivative, can readily be carried out by techniques to be exemplified in detail hereinafter. For example, a solution of secondary amine, such as morpholine, piperidine, dimethylamine, di-n-butylamine, and the like, in about ten volumes of ethanol or water can be treated at 25° C. with an equimolar amount of 37% aqueous formaldehyde and, after stirring the mixture of 15 minutes, an amount of comenic acid approximately equivalent to 0.75 molar equivalent of amine originally taken is added, preferably all at one time. After about 5 minutes of stirring at about 30° C., all of the comenic acid has gone into solution and, after an additional ten minutes, the corresponding 6-N,N-disubstituted-aminomethylcomenic acid crystallizes out. To complete the reaction, the reaction mixture can be stirred for about an additional hour. To isolate the product, it is preferred to allow the mixture to stand for about 16 hours at 25° C. then to collect the crystals on a filter. After drying in the air, there is obtained the product in an amount corresponding to a yield of from about 80 to about 95 percent of theoretical.

With respect to the Step (3) of the process, the reduction of 6-N,N-disubstituted-aminomethylcomenic acid to the corresponding 6-methylcomenic acid, this can be carried out with chemical reducing agents such as, for example, sodium hydrosulfite, lithium hydrosulfite, potassium hydrosulfite, calcium hydrosulfite, magnesium hydrosulfite, zinc hydrosulfite or ammonium hydrosulfite. Since certain difficulties are encountered with respect to isolation of the product if other reducing agents such as for example, metal-acid reducing agent combinations or hydrogen in the presence of a noble metal catalyst are employed, it is preferred to use hydrosulfite salts for this purpose. Reduction with sodium hydrosulfite may be carried out in accordance with the procedure described hereinbefore for the reduction of the corresponding 6-hydroxymethylcomenic acid, and is exemplified in detail hereinafter.

Maltol may be made by decarboxylation of 6-methylcomenic acid as described hereinbefore.

The valuable new gamma-pyrones of the instant invention may also be prepared by a synthetic route which proceeds via 6-methylkojic acid, one of the valuable new intermediates disclosed and claimed herein. This procedure is outlined in the following reaction sequence:



With respect to Step (1), the hydroxymethylation of kojic acid, 6-hydroxymethylkojic acid can be obtained in yields of up to 90 percent according to the following general procedure: Kojic acid is suspended in about 4 parts by weight of water and to this is added enough 50% by weight sodium hydroxide solution to bring the pH of the mixture to at least about 8. To the resulting mixture is added 1 molar equivalent based on the kojic acid of formaldehyde as a 37% aqueous solution and the reaction mixture is allowed to stand at about 25° C. for about 2 hours. The reaction mixture is then acidified to a pH of about 1 by adding 50% by weight of acid such as, for example, sulfuric, hydrochloric, and the like. After cooling the suspension to about 5° C., the product can be collected by filtration. An additional amount can be obtained by concentration of the filtrate in vacuo to about ⅓ volume. The product can be purified by recrystallization from methanol to obtain 6-hydroxymethylkojic acid, M.P. 148–150° C.

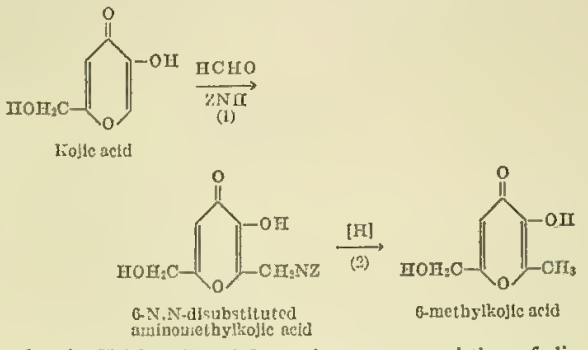
The reduction of 6-hydroxymethylkojic acid to the new compound, 6-methylkojic acid, Step (2), can readily be carried out according to the following procedure. A suspension of 6-hydroxymethylkojic acid in from about 5 to about 10 volumes of water and containing about 2 molar equivalents of zinc metal dust, based on the acid, is treated by the dropwise addition of about 4 molar equivalents of concentrated hydrochloric acid. Such addition is conveniently carried out at a rate so that the temperature does not rise above about 65° C.; the time required is approximately 15 minutes. To complete the reaction, the mixture can then be heated and stirred at about 60 to 70° C. for an additional 1.5 hours. The product can be isolated by heating the suspension to about 90° C., filtering to remove unreacted zinc metal, adjusting pH of the filtrate to about 2 by the addition of 12 N sodium hydroxide solution and allowing the suspension to stand at 5° C. until crystallization is complete; about 16 hours is sufficient. The product which crystallizes can be collected upon a filter and dried in the air at about 25° C. There is obtained in about 50% yield 6-methylkojic acid. A small additional amount of product can be obtained by concentration of the filtrate to about one-fifth volume followed by extraction with about 5 volumes of solvent such as chloroform, evaporation of the solvent layer, and recrystallization of the residue from an alcohol such as, for example, isopropanol.

With respect to Step (3), the oxidation of 6-methylkojic acid to 6-methylcomenic acid, the procedure is substantially the same as that described in the aforesaid copending application for the oxidation of kojic acid to comenic acid and is exemplified in detail hereinafter. For example, 6-methylkojic acid is suspended in from about 4 to about 10 volumes of water and approximately 2 molar equivalents of sodium hydroxide are added as a 50% aqueous solution. After the reaction mixture is completely homogenous, from about 1 to about 3% of palladium based on 6-methylkojic acid is added as a 5% palladium on carbon catalyst suspended in 50% by weight of water. The reaction mixture is then maintained at about 30° C. by external cooling and air is blown into the reaction mixture at a rate of about 5 milliliters per minute per gram of 6-methylkojic acid for about 16 hours. The product is isolated by removing the catalyst by filtration and acidifying the filtrate with concentrated hydrochloric acid to a pH of below about 1. Light colored crystals separate and, after cooling to 5° C., the product is collected on a filter and is dried in the air at about 25° C. There is obtained 6-methylcomenic acid in a yield corresponding to up to about 80% of the theoretical amount.

Maltol is prepared by decarboxylation of 6-methylcomenic acid as is described hereinabove and exemplified hereinafter.

An alternative process for the preparation of 6-methylkojic acid involves the preparation of the corresponding

Mannich base from kojic acid. This procedure is outlined in the following sequence of reactions:



wherein ZN is selected from the group consisting of di-lower alkylamino, said alkyl groups containing up to about 4 carbon atoms, piperidino and morpholino.

With respect to Step (1) of the reaction, the conversion of kojic acid to the corresponding Mannich derivative, this reaction may be carried out according to the general technique described for the preparation of the corresponding Mannich derivative of comenic acid described hereinbefore. For example, a solution of secondary amine, such as morpholine, piperidine, dimethylamine, di-n-butyl amine, or the like, in from about 5 to about 15 volumes of water or alcohol such as, for example, ethanol, is treated with an equimolar amount of formaldehyde conveniently taken as a 37% aqueous solution and the resulting mixture is stirred vigorously for 15 minutes. Then kojic acid in an amount corresponding to about 0.75 molar equivalent of secondary amine is added rapidly After about five minutes, most of the kojic acid has gone into solution and after about ten minutes, the Mannich product begins to crystallize and separate from the reaction mixture. The reaction mixture is stirred for an additional 45 minutes, then is allowed to stand for an additional 12 to 16 hours. The product is collected by suction filtration and is dried in the air at about 25° C. There is obtained, in yields corresponding to from about 75 to about 95%, the 6-N,N-disubstituted aminomethylkojic acid.

With respect to Step (2), the reduction of the 6-Mannich derivative of kojic acid to the novel 6-methylkojic acid of the instant invention, it is convenient to carry out this reaction in the presence of metal-acid reducing agent combinations. For example, a suspension is prepared containing the 6-N,N-disubstituted aminomethylkojic acid in from about 3 to about 10 parts by weight of water and about 2 gram atoms of zinc metal dust is added. This mixture is stirred and there is added from about 2.5 to about 5 equivalents of concentrated hydrochloric acid at such a rate that the temperature can be maintained in the range of 50–55° C.; this requires about 30 minutes. After the acid has been added, the reaction is completed by heating and stirring at 50–55° C. for an additional 1.5 hours. The product is isolated by filtering off the unreacted zinc metal at about 90° C., adjusting the pH of the filtrate to about 2.0 with 50% aqueous sodium hydroxide solution and cooling the resulting suspension to 5° C. The pH is then increased to about 10 by the addition of more aqueous sodium hydroxide, the precipitated zinc hydroxide is removed by filtration and the filtrate is re-adjusted to pH 2.0 by the addition of concentrated hydrochloric acid. The acidic solution is concentrated in vacuo to about one-fifth volume and the concentrate is cooled to 5° C. After having allowed the suspension to stand for about 48 hours at 5° C., the crystalline product, which has precipitated, is collected. There is obtained in good yield, 6-methylkojic acid.

6-methylcomenic acid is prepared by oxidation of 6-methylkojic acid as described hereinbefore and exemplified hereinafter. Maltol is prepared by the decarboxyla-

tion of 6-methylcomenic acid as described hereinbefore and exemplified hereinafter.

The following examples are illustrative of the processes of this invention.

Example I

In an 8-liter stainless steel vessel fitted with a stirrer and an air sparger is placed a suspension of 350 grams of kojic acid in 3500 ml. of water. The pH is adjusted to 11.1 by addition of 256 ml. of 50 percent aqueous sodium hydroxide and then 142 g. (7.1 g. as metal) of a 5 percent palladium on charcoal catalyst is added. Air is passed into the suspension at a rate of 6 ml. per minute per gram of kojic acid. The reaction, which is slightly exothermic, is maintained at a temperature of about 20–22° C. by occasional application of external cooling. After 11 hours the reaction mixture is filtered to remove the catalyst and is treated with 600 ml. of concentrated hydrochloric acid. The crystals of comenic acid which precipitate from the pH 0.5 mixture are removed by filtration, washed with a small amount of cold water and are air-dried. There is obtained 328 g. of product. This is 85.3 percent of the theoretical yield. Titration data indicate the product to be 99.2 percent pure; therefore, there is obtained an 84.6 percent yield of comenic acid as corrected for purity.

Example II

Comenic acid, 156 g., 1 mol, is mixed with 550 ml. of water, and the pH is adjusted to 10 with a 50% aqueous sodium hydroxide solution. The mixture is treated with 83.1 g. of 37% aqueous formaldehyde and is stirred at 25° C. for 1.5 hours. The pH is then adjusted to 0.8 by the addition of concentrated hydrochloric acid, 300 ml. of water is added and the suspension is cooled to 5° C. and filtered. There is obtained 209 g. of product; this represents a nearly quantitative yield. The product when analyzed indicates that 6-hydroxymethylcomenic acid is partially present in the form of its sodium salt.

The crude 6-hydroxymethylcomenic acid is converted completely to the free acid by dissolving 7.88 g. in 175 ml. of boiling acetic acid and treating the hot mixture with a solution of 1 g. of concentrated sulfuric acid in 20 ml. of acetic acid. The precipitate of inorganic salt which forms is removed by filtration and the filtrate is evaporated to one-half volume and the product is allowed to crystallize at 25° C. The crystalline product is collected by filtration and weighs 2.5 g. Evaporation of the filtrate to one-half volume affords a second crop weighing 0.38 g. Recrystallization of the first crop from hot water yields a material with a melting point of 178–179° C. and having a neutral equivalent of 187 and 94.1; values calculated for 6-hydroxymethylcomenic acid are 186 and 93.

Analysis.—Calcd. for $C_7H_6O_6$: C, 45.16; H, 3.23. Found: C, 45.42, 45.16; H, 3.41, 3.32.

Example III

A series of reactions is carried out by the procedure of Example II except that the pH of the reaction mixtures are 3, 5, 7 and 9. No product can be detected by paper chromatographic assay after the reactions at pH 3 and 5. After carrying out the reaction at pH 7, a small amount of product can be detected after 45 minutes of reaction time. After carrying out the reaction at pH 9, a moderate yield of 6-hydroxymethylcomenic acid is formed, but considerable comenic acid material is still present after 2 hours. In contrast, the procedure of Example II at pH 10 led to nearly complete conversion of comenic acid to 6-hydroxymethylcomenic acid after about 1.5 hours.

Example IV

6-hydroxymethylcomenic acid prepared as in Example II, 1.97 g., is mixed with 0.5 g. of 5% palladium on carbon catalyst (50% in water), 200 ml. of glacial acetic acid and 0.25 ml. of concentrated sulfuric acid. The mixture is agitated in a hydrogen atmosphere at an initial pressure of 50 pounds and, after 41 minutes, a pressure drop of 13 pounds, equivalent to 0.01 mole of hydrogen, is observed. The mixture is evaporated in a vacuum corresponding to about 1 mm. Hg to a small volume and is allowed to crystallize. About 0.7 g. of crystals are collected by filtration; paper chromatography indicates that they are comprised of 6-hydroxymethylcomenic acid and methylcomenic acid in approximately equal amounts.

The procedure is repeated substituting the following catalysts for palladium on carbon on an equal weight based on the metal basis: platinum black, palladium black, platinic oxide and platinum on carbon. Substantially the same results are obtained.

Example V

Dry hydrogen bromide gas is passed rapidly into a stirred mixture of crude 6-hydroxymethylcomenic acid, 35 g., 0.18 mole, and glacial acetic acid, 210 cc. The temperature rises to 55–60° within 15 minutes, then the mixture is heated to 90–110° C., is maintained at that temperature for 2 hours and then is cooled to 30° C. The reaction mixture is filtered, the filtrate is concentrated in a vacuum corresponding to about 5 mm. of Hg to one-sixth volume, and the crystals which precipitate are removed by filtration. There is obtained 39.1 g. of 6-bromomethylcomenic acid corresponding to a 90% yield of theory. An additional small amount of product is obtained by concentration of the filtrate to one-half volume. Recrystallization of the crude product from ethyl acetate gives pure 6-bromomethylcomenic acid, M.P. 197–197.5° C.

Analysis.—Calcd. for $C_7H_5O_5Br$: C, 33.75; H, 202. Found: C, 33.78; H, 1.94.

The same procedure is carried out substituting hydrogen chloride for hydrogen bromide and 20 g. of 6-hydroxymethylcomenic acid is converted to 14.4 g. of 6-chloromethylcomenic acid.

The procedure is repeated substituting hydrogen iodide for the corresponding hydrogen bromide. 6-iodomethylcomenic acid is obtained.

Example VI

6-bromomethylcomenic acid, 1.24 g., is mixed with 100 ml. of glacial acetic acid, 0.5 g. of a 5% palladium on carbon catalyst (50% in water) and 0.385 g. of ammonium acetate and the mixture is shaken in an atmosphere of hydrogen at 25° C. and at an initial pressure of 50 pounds per square inch. The calculated amount of hydrogen is absorbed in 15 minutes. The reaction is stopped, the mixture is filtered and the filtrate evaporated in vacuo. There is obtained 1.18 g. of crystalline residue. Recrystallization of the residue from a 1:1 acetone-water mixture affords 6-methylcomenic acid, M.P., 237–238° C. (decomposition).

The procedure is repeated substituting 4.1 g. of 6-chloromethylcomenic acid prepared as in the preceding example; 80% of the theoretical amount of hydrogen is absorbed in 75 minutes. Evaporation of the filtered reaction mixture yields an oily product; this is crystallized from acetone to yield 1.8 g. of material melting at 228–232° C.

The procedure is repeated substituting 6-iodomethylcomenic acid for the corresponding 6-bromomethylcomenic acid. Substantially the same results are obtained.

Example VII

6-bromomethylcomenic acid, 5.0 g., 0.02 mole, is added portionwise during 15 minutes to a stirred mixture of 35 ml. of water and 5.22 g., 0.03 mole, of sodium hydrosulfite while the pH of the mixture is kept between 5 and 5.5 by incremental addition of 1 N sodium hydroxide. The mixture, which warms to 40° C. spontaneously, is stirred for an additional hour, then is heated to 58–63° C. and stirred for an additional 2.25 hours. It is then acidi-

fied with concentrated hydrochloric acid to pH 0.9, the white precipitate which forms is removed by filtration, and the filtrate is allowed to be cooled to 5° C. and crystals are formed. Filtration provides 1.462 g., 46% yield, of 6-methylcomenic acid, M.P. 237.5–238.0° C. A small amount of additional product can be isolated from the filtrate by concentration to ½ volume, cooling and filtering.

The procedure is repeated substituting for the sodium hydrosulfite the following salts: lithium hydrosulfite, potassium hydrosulfite, calcium hydrosulfite, magnesium hydrosulfite, zinc hydrosulfite and ammonium hydrosulfite. Substantially the same results are obtained.

The procedure is repeated substituting for the 6-bromomethylcomenic acid the following: 6-chloromethylcomenic acid and 6-iodomethylcomenic acid. Substantially the same results are obtained.

Example VIII

6-methylcomenic acid, 3.0 g., 0.012 mole, is suspended in 12 ml. of dimethyl phthalate in a 25 ml. 3-neck round-bottomed flask equipped with mechanical stirrer, thermometer and short distillation head connected in turn to a round-bottomed receiver. The mixture is stirred and heated and it is found that most of the methylcomenic acid has dissolved when the temperature reaches 150° C. When the temperature reaches about 215° C., vigorous evolution of carbon dioxide occurs and this continues for about 15 minutes. The external temperature is allowed to rise to 250° C., then the mixture is cooled to about 100° C. and a vacuum of about 20 mm. of Hg is applied. The reaction mixture is distilled at an external temperature of about 180–250° C. and distillation is continued until very little material remains in the flask. Most of the distillation occurs at vapor temperature of 140–150° C. The distillate is cooled to 15° C. and the crystalline material which precipitates is collected by suction filtration. The product is washed with 5 ml. of ethyl acetate and is dried. There is obtained maltol in good yield, M.P. 157–160° C.

The procedure is repeated using 10.0 g. of 6-methylcomenic acid and 40 ml. of dibutyl carbitol. The reaction mixture is heated in the range of 230–245° C. for about 45 minutes, then is distilled as described in the preceding procedure. The distillate is cooled to 25° C. and maltol is collected upon a filter then is dissolved in 30 ml. of hot water, the solution is filtered hot, is cooled to 10° C. and maltol is allowed to crystallize. The maltol is collected upon a filter and air dried. Further concentration of the filtrate to ⅓ volume and filtration to remove the crystalline precipitate affords a small additional amount of product.

The procedure is repeated substituting 25 ml. of α-methylnaphthalene for the corresponding 40 ml. of dibutyl Carbitol. There is obtained maltol, M.P., 160–161.5° C., in good yield.

Example IX

A mixture of morpholine, 46.8 g., 0.534 mole, formaldehyde, 37% aqueous, 42.8 g., 0.534 mole, and anhydrous ethanol, 534 ml., is stirred for 15 minutes. Comenic acid, 62.4 g., 0.4 mole, is added all at once, and the mixture is stirred at room temperature for one hour, cooled to 10° C., and filtered. The 6-morpholinomethylcomenic acid weighs 99 g. A recrystallized sample, M.P. 173–174° C., had the following analysis: C, 48.61; H, 5.51; N, 5.23. Calcd. for $C_{11}H_{13}NO_6$—H_2O: C, 48.35; H, 5.53; N, 5.13. Calculated as the monohydrate, the crude yield was 91%.

The procedure is repeated substituting a molecular equivalent amount of piperidine for morpholine. 6-piperidinomethylcomenic acid is obtained.

The procedure is repeated substituting a molecular equivalent of dimethylamine for the morpholine. 6-dimethylaminomethylcomenic acid is obtained.

The procedure is repeated substituting a molecular equivalent of di-n-butylamine for the morpholine. 6-di-n-butylaminomethylcomenic acid is obtained.

Example X

6-morpholinomethylcomenic acid, 5.1 g., 0.02 mole, is added portionwise to a mixture of sodium hydrosulfite, 5.22 g., 0.03 mole, and 35 ml. of water while the pH was maintained between 5.0 and 6.0 by the addition of 12 N sodium hydroxide solution as needed. The addition requires 15 minutes and the temperature rises to 42° C. No product can be detected by paper chromatography after stirring the mixture at ambient temperature for 15 minutes. The mixture is then heated to reflux temperature and after 15 minutes at this temperature, paper chromatography indicates the presence in the reaction mixture of 6-methylcomenic acid in moderate yield.

The procedure is repeated substituting for the 6-morpholinomethylcomenic acid the following: 6-piperidinomethylcomenic acid, 6-dimethylaminomethylcomenic acid and 6-di-n-butylaminomethylcomenic acid. Substantially the same results are obtained.

The procedure is repeated substituting for the sodium hydrosulfite, stoichiometrically equivalent amounts of the following: lithium hydrosulfite, potassium hydrosulfite, calcium hydrosulfite, magnesium hydrosulfite, zinc hydrosulfite and ammonium hydrosulfite. Substantially the same results are obtained.

Example XI

In a 2-l. 3-necked round-bottomed flask equipped with stirrer is placed kojic acid, 142 g., 1.0 mole, and 500 ml. of water. To this is added 50 ml. of 50% aqueous sodium hydroxide solution and the pH of the resulting mixture reaches 10. After the reaction stands for five minutes a small amount of crystalline material begins to separate. To the mixture then is added 76 ml. of 37% aqueous formaldehyde. The reaction mixture becomes homogeneous and is allowed to stand at 25° C. for 2 hours. The mixture then is treated with 65 ml. of 50 wt. percent aqueous sulfuric acid solution and is cooled to 5° C. whereupon 6-hydroxymethylkojic acid crystallizes from solution. The crystals are collected upon a filter, are partially air-dried and then are dissolved in 500 ml. of hot methanol, the solution is filtered while hot, and allowed to cool and the product crystallizes at 20 degrees C. The crystals are collected upon a filter and after air-drying weigh 81.1 g., M.P., 148–150° C. A further 21.0 g. of 6-hydroxymethylkojic acid is obtained by concentration of the methanol filtrate to about ¼ volume. Concentration of the aqueous filtrate affords additional 38.7 g. of product. There is obtained a total of 140.8 g. of 6-hydroxymethylkojic acid, an 81% yield of the theoretical.

Example XII

In a 500-ml. flask fitted with stirrer, thermometer, condenser and addition funnel are placed 180 ml. of water, 6-hydroxymethylkojic acid prepared as in Example XI, 34.4 g., 0.2 mole, and zinc metal dust, 26.0 g., 0.4 mole. To this mixture is added dropwise 95 ml., 1.13 eq., of concentrated hydrochloric acid at such a rate that the temperature does not rise about 65° C.; the time required is approximately 15 minutes. The reaction mixture is then stirred and heated at 60 to 70° C. for an additional 1.5 hours. The mixture then is heated to 90° C. and filtered to remove unreacted zinc metal. The pH of the filtrate is adjusted to about 2.0 by the addition of 12 N sodium hydroxide solution and the resulting mixture is allowed to stand at 5° C. for 12 hours. The yellow product which crystallizes is collected on a filter, pressed free of solvent and air-dried. The 6-methylkojic acid weighs 13.9 g., 45% yield of theory, M.P. 138–140° C.

6-methylkojic acid is further purified by dissolving 15.2 g. in 30 ml. of hot water and the resulting mixture is cooled to 5° C. whereupon the product crystallizes. The product is removed by filtration and is dried in a desiccator over phosphorous pentoxide. After a further re-

crystallization from an equal weight methanol there is obtained 6-methylkojic acid, M.P., 145–145.5° C.

Analysis.—Calcd. for $C_7H_8O_4$: C, 53.84; H, 5.16. Found: C, 54.05; H, 5.08.

An ultraviolet absorption spectrum for this compound in ethanol solution has maxima at 245 mμ, ε=4,840 and 276 mμ, ε=7,950, respectively.

The procedure is repeated substituting for the zinc dust, stoichiometrically equivalent amounts of the following metals: iron, aluminum, tin and magnesium. Substantially the same results are obtained.

The procedure is repeated substituting for the hydrochloric acid stoichiometrically equivalent amounts of the following acids: sulfuric, formic, acetic and isodecanoic. With the C–10 acid, it is desirable to add an appropriate quantity of a co-solvent to the predominately aqueous system to promote solubility. Substantially the same results are obtained.

Example XIII

In a 500-ml. flask is placed 40 g., 0.26 mole, of 6-methylkojic acid, 270 ml. of water and 20.5 g., 0.512 mole, of sodium hydroxide. After all of the solids have gone into solutions, 27.5 g. of a 5% palladium on charcoal catalyst containing 50 wt. percent of water is added. This is equivalent to 1.72% of palladium by weight of 6-methylkojic acid. The reaction mixture is cooled by the external application of a water bath and the temperature is maintained at 30° C. while air is blown through the reaction mixture at a rate of about 200–250 ml. per minute for 16 hours. After this time, the catalyst is collected upon a filter and then the filtrate is acidified with concentrated hydrochloride acid to a pH of below 1. A light orange-colored product crystallizes from the mixture, and after cooling well in an ice bath, the product is collected upon a filter and is air-dried. There is obtained 34.0 g. of 6-methylcomenic acid, M.P., 233–235° C., with decomposition, a 78% yield of theoretical. This product is converted to maltol in good yield by the method described in Example VIII.

Example XIV

In a 12-l. flask are placed 3.5 liters of ethanol, 350 g., 4.0 moles, or morpholine and 320 g., 4.0 moles, of 37% aqueous formaldehyde. The reaction mixture is stirred for about 5 minutes during which time it is observed to warm slightly, then is stirred vigorously for 14 minutes. To the reaction mixture is added 430 g., 3.0 moles, of kojic acid all at once together with an additional 250 ml. of ethanol. After about 5 minutes of stirring, most of the kojic acid has gone into solution and, after about 10 minutes, the product is observed to crystallize out. The reaction mixture is stirred for an additional 45 minutes, then is allowed to stand overnight. The crystals are collected upon a filter, and are air-dried. After drying, 6-morpholinomethylkojic acid, 632 g., M.P., 164–165° C., is obtained. This corresponds to an 88% yield of the theoretical.

The procedure is repeated substituting for morpholine, stoichiometrically equivalent amounts of the following amines: piperidine, dimethylamine and di-n-butylamine. There are obtained respectively, 6-piperidinomethylkojic acid, 6-dimethylaminomethylkojic acid and 6-di-n-butylaminomethylkojic acid.

Example XV

In a 2-l. round-bottom flask equipped with stirrer, condenser, thermometer and addition funnel is placed 96.4 g., 0.4 mol, of 6-morpholinomethylkojic acid, zinc metal dust, 52 g., 0.8 g-atoms, and 720 ml. of water. To this mixture is added 225 ml., 2.67 equivalents, of concentrated hydrochloric acid at such a rate that the temperature remains in the 50–55° C. range; the addition requires about 30 minutes. After all the acid has been added, the reaction mixture is stirred and heated at 50–55° C. for an additional 1.5 hours. The reaction mixture then is heated to 90° C. and unreacted zinc metal is recovered by filtration. The light yellow filtrate is treated with 65 ml. of 50% aqueous sodium hydroxide solution during which time the pH reaches about 2. The resulting mixture is cooled to 5° C. in an ice-water bath, then the pH is raised to 10 by the addition of 85 ml. of additional 50% sodium hydroxide solution. The zinc hydroxide which precipitates is removed by filtration, the filter cake is washed with 25 ml. of water and the washings are combined with the original filtrate. The pH of the filtrate is adjusted to 2.0 by the addition of about 65 ml. of concentrated hydrochloric acid. The acidic solution is concentrated to about one-fourth volume at a pressure corresponding to about 20 mm. Hg. The concentrate is cooled to 5° C. and is allowed to stand for 48 hours. The crystalline product which precipitates is collected upon a filter and is air-dried. There is obtained 22.7 g. of 6-methylkojic acid, 36% yield of theoretical, M.P., 133–136° C. This product can be further purified by recrystallization from an equal weight of methanol, M.P., 144–145° C.

The procedure is repeated substituting for the 6-morpholinomethylkojic acid, stoichiometrically equivalent amounts of the following Mannich bases: 6-piperidinomethylkojic acid, 6-dimethylaminokojic acid, 6-di-n-butylaminokojic acid. Substantially the same results are obtained.

The procedure is repeated substituting for the zinc dust, stoichiometrically equivalent amounts of the following metals: iron, aluminum, tin and magnesium. Substantially the same results are obtained.

The procedure is repeated substituting for the hydrochloric acid stoichiometrically equivalent amounts of the following acids: sulfuric, formic, acetic and isodecanoic. With the C–10 acid, it is desirable to add an approprite quantity of a co-solvent to the predominately aqueous system to promote solubility. Substantially the same results are obtained.

6-methylkojic acid is converted by the procedure of Example XIII to 6-methylcomenic acid and maltol is formed therefrom by the procedure of Example VIII.

Example XVI

The procedure of Example XV is repeated substituting, respectively, for the 6-morpholinomethylkojic acid stoichiometrically equivalent amounts of the following: 6-bromomethylcomenic acid, 6-chloromethylcomenic acid and 6-iodomethylcomenic acid prepared as described in Example V. There is obtained 6-methylcomenic acid.

Example XVII

To a suspension of 20 g. (0.1 mole) of 6-hydroxymethylcomenic acid (prepared as in Example II) and 13.1 g. (0.2 mole) of zinc metal dust in 130 ml. of water is added, during 10 minutes, 35 ml. of concentrated hydrochloric acid. The temperature rises from 25° to 60° and then the mixture is filtered to remove 1.7 g. of unreacted zinc metal and the filtrate is treated with an aqueous solution of 22.5 g. (0.178 mole) of oxalic acid. The precipitated zinc oxalate is removed by filtration, the filtrate is adjusted to pH 1 by addition of 20% aqueous sodium hydroxide solution, and the mixture is evaporated to dryness in vacuo. The residue is mixed with 4 parts by weight of glacial acetic acid and insoluble organic salts are removed by filtration. Evaporation of the filtrate in vacuo and trituration of the residue with hot ethyl acetate followed by cooling affords 2.6 g. of 2,3-dihydro-6-methylcomenic acid, M.P., 156–157° C. A second crop, 2.91 g., is obtained by evaporation of the filtrate to ⅓ volume and filtering of the crystals which form. The combined yield is 32%. Neutral equivalent, calcd., 172; found, 174.

Analysis.—Calcd. for $C_7H_8O_5$: C, 48.84; H, 4.68. Found: C, 49.11; H, 4.78.

The procedure is repeated substituting for the zinc

dust, stoichiometrically equivalent amounts of the following metals: iron, aluminum, tin and magnesium. Substantially the same results are obtained.

The procedure is repeated substituting for the hydrochloric acid stoichiometrically equivalent amounts of the following acids: sulfuric, formic, acetic and isodecanoic. With the C–10 acid, it is desirable to add an appropriate quantity of a co-solvent to the predominately aqueous system to promote solubility. Substantially the same results are obtained.

Example XVIII

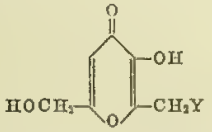
2,3-dihydro-6-methylcomenic acid, 1.72 g., 0.01 mole, is dissolved in 50 ml. of glacial acetic acid and the solution is treated with 4.53 g., 0.01 mole of lead tetraacetate. Within a few minutes, the temperature rises from 24° to 30°. The mixture is stirred at 25° C. for one hour, then is heated to 41° C. and stirred for 1 hour, during which time 30 cc. of CO_2 is evolved. The mixture is then heated to 62° C. for an hour during which time 20 cc. of CO_2 is evolved. The mixture is finally heated to refluxing and stirred at this temperature for an hour during which time an additional 110 cc. of CO_2 is evolved. The mixture is cooled to 25° C. and is diluted with an equal volume of water then is extracted twice with equal volumes of chloroform and twice with an equal volume of ether. The organic extracts are combined, dried with 10 wt. percent of anhydrous sodium sulfate, and the solvents are evaporated. There is obtained 0.85 g. of maltol, a yield corresponding to 67% of the theoretical.

Example XIX

The procedure of Example VI is repeated substituting for the 6-bromomethylcomenic acid, stoichiometrically equivalent amounts of the following: 6-morpholinomethylcomenic acid, 6-piperidinomethylcomenic acid, 6-dimethylaminomethylcomenic acid and 6-di-n-butylaminomethylcomenic acid. 6-methylcomenic acid is obtained.

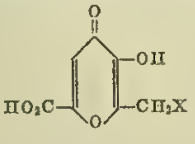
What is claimed is:

1. A process for the preparation of maltol which comprises treating kojic acid wth formaldehyde and a reagent selected from the group consisting of alkali metal hydroxides, di-lower alkylamines, said alkyl radicals each containing up to about four carbon atoms, piperidine and morpholine at a pH of at least about 5 to form a compound of the formula



wherein Y is selected from the group consisting of hydroxyl, di-lower alkylamino, piperidino and morpholino; treating said compound under reducing conditions with a metal-acid reducing agent combination to form 6-methylkojic acid; oxidizing said compound to 6-methylcomenic acid and decarboxylating 6-methylcomenic acid to form maltol.

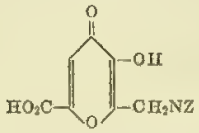
2. A process for the preparation of maltol which comprises treating an aqueous solution of kojic acid, adjusted to a pH of at least about 10, with oxygen in the presence of a noble metal catalyst to form comenic acid; treating said comenic acid with formaldehyde at a pH of at least about 7 to form 6-hydroxymethylcomenic acid; treating said compound with a reagent selected from the group consisting of hydrogen chloride, hydrogen bromide and hydrogen iodide to form a compound of the formula



wherein X is selected from the group consisting of chloro, bromo and iodo; treating said compound under reducing conditions with a reagent selected from the group consisting of hydrogen activated by noble metal catalysts, alkali metal hydrosulfites, alkaline earth metal hydrosulfites, zinc hydrosulfite, ammonium hydrosulfite and metal-acid reducing agent combinations to form 6-methylcomenic acid and decarboxylating said compound to form maltol.

3. A process for the preparation of maltol which comprises treating an aqueous solution of kojic acid adjusted to a pH of at least about 10 with oxygen in the presence of a noble metal catalyst to form comenic acid; treating said comenic acid with formaldehyde at a pH of at least about 7 to form 6-hydroxymethylcomenic acid; treating said 6-hydroxymethylcomenic acid in acetic acid solution with hydrogen in the presence of a noble-metal catalyst to form 6-methylcomenic acid; and decarboxylating said 6-methylcomenic acid to form maltol.

4. A process for the preparation of maltol which comprises treating an aqueous solution of kojic acid adjusted to a pH of at least about 10 with oxygen in the presence of a noble metal catalyst to form comenic acid; treating said comenic acid with formaldehyde and a reagent selected from the group consisting of di-lower alkyl amines, morpholine, and piperidine to form a compound of the formula



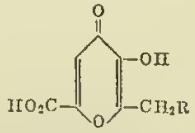
wherein NZ is selected from the group consisting of di-lower alkylamino, morpholino and piperidino; treating said compound under reducing conditions with a reagent selected from the group consisting of hydrogen activated by noble metal catalysts, alkali metal hydrosulfites, alkaline earth metal hydrosulfites, zinc hydrosulfite, ammonium hydrosulfite and metal-acid reducing agent combinations to form 6-methylcomenic acid; and decarboxylating said compound to form maltol.

5. A process for the preparation of maltol which comprises treating comenic acid with formaldehyde at a pH of at least about 7 to form 6-hydroxymethylcomenic acid; treating said 6-hydroxymethylcomenic acid under reducing conditions with a metal-acid reducing agent combination to form 2,3-dihydro-6-methylcomenic acid and treating said compound with lead tetraacetate and heat to form maltol.

6. A process as in claim 5 wherein said metal is zinc and wherein said acid is hydrochloric acid.

7. A process as in claim 5 wherein said metal is zinc. and wherein said acid is acetic acid.

8. A compound of the formula



wherein R is selected from the group consisting of hydrogen, hydroxyl, chloro, bromo, iodo, di-lower alkylamino, piperidino and morpholino.

9. A compound as in claim 8 wherein R is hydrogen.

10. A compound as in claim 8 wherein R is hydroxyl.

11. 2,3-dihydro-6-methylcomenic acid.

References Cited in the file of this patent

UNITED STATES PATENTS

2,907,773 Krimmel ---------- Oct. 6, 1959

OTHER REFERENCES

Woods: Journal American Chemical Society, vol. 68, page 2744 (1946).

United States Patent Office

3,171,842
Patented Mar. 2, 1965

3,171,842

PREPARATION OF GAMMA PYRONES

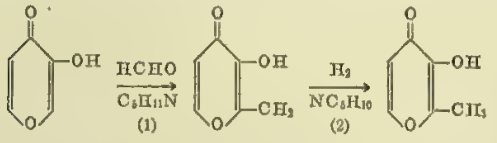
Bryce E. Tate, Niantic, Conn., assignor to Chas. Pfizer & Co., Inc., New York, N.Y., a corporation of Delaware

No Drawing. Filed June 13, 1962, Ser. No. 202,102
5 Claims. (Cl. 260—345.9)

The present invention relates to a process for the preparation of gamma-pyrones. More particularly it is concerned with an improved process for the preparation of maltol, 3-hydroxy-2-methyl-4-pyrone, a particularly valuable gamma-pyrone, which is useful, among other things, for its flavor and aroma-enhancing properties.

While maltol is obtained commercially from wood, for example, by difficult and expensive extraction processes, it is known to the art that it can also be obtained by chemical syntheses from other gamma-pyrones. Thus the preparation of maltol from the freely-available and economical starting material, kojic acid, 2-hydroxymethyl-5-hydroxy-4-pyrone, is disclosed in the pending application of Bryce E. Tate and Robert L. Miller, Serial Number 171,732, filed February 7, 1962, now Patent No. 3,130,-204, and assigned to the assignee of the instant application.

There is also known to the art another synthesis of maltol which is based on the disclosure of M. A. Spielman and M. Freifelder in volume 69, Journal of the American Chemical Society, pp. 2908–9 (1947). This synthesis is carried out in accordance with the following scheme:



pyromeconic acid — 2-piperidinomethyl-pyromeconic acid — maltol

The instant application is concerned with an improvement in the Spielman et al. process.

In the Spielman et al. article cited, it is disclosed that the yield in the step (1) in the reaction sequence is 43% and in step (2) the highest yield is reported to be 17%; thus an overall yield of maltol of only 7.3% based on pyromeconic acid, is obtained. It is noteworthy that after many experiments, this low yield was only obtained after conducting the reduction at a very high pressure (100 atmospheres) and in the presence of an expensive noble metal catalyst (palladium-on-charcoal).

It has now been found that application of improved processing conditions recently disclosed to the art by O'Brien et al. in volume 25, Journal of Organic Chemistry, p. 86 (1960), to step (1) in the sequence and substituting pyromeconic acid for the kojic acid employed therein, the yield of 2-di-substituted-aminoethylpyromeconic acid is increased to about 90% and furthermore, that following the application of the improved process contemplated by the instant invention to step (2) it is found that the yield is increased to 53%; thus an overall yield of maltol of 49%, based on pyromeconic acid, is obtained. An additional advantage is that the reaction can be carried out at atmospheric pressure in ordinary plant equipment and is not necessary to employ expensive and readily-poisoned catalysts.

Thus, application of the improvements of O'Brien et al. to increase the yield of 2-di-substituted-aminomethylpyromeconic acid followed by application of the improved process of the instant invention to the maltol-formation step allows the yield of maltol to be increased nearly four-fold to a comercially-feasible level and permits substantial savings in process and equipment costs.

It is accordingly a principal object of the present invention to provide an improved means to obtain maltol from readily available, economical gamma-pyrone starting materials.

This and other objects obvious to those skilled in the art may be readily achieved by application of the improved process of the present invention which comprises preparing maltol by treating a 2-di-substituted-aminomethylpyromeconic acid with a metal-acid reducing agent combination.

By the term 2-di-substituted-aminomethylpyromeconic as employed herein and in the appended claims it is to be understood that the present invention contemplates reaction products derived by treatment of pyromeconic acid with formaldehyde and a secondary amine and known to those skilled in the art as Mannich bases. In addition to the 2-piperidinomethylpyromeconic acid disclosed by Spielman et al., a number of other Mannich bases may be used. 2-dimethylaminomethylpyromeconic acid, 2-di-n-butylamino-pyromeconic acid and 2-morpholinomethylpyromeconic acid are examples of 2-di-substituted-aminomethylpyromeconic acids which are especially useful.

With respect to the term metal-acid reducing agent combinations as employed herein and in the appended claims, it is meant, as is obvious to those skilled in the art, combinations of acids with metals appropriately located in the electromotive series of the elements, which combinations provide a reducing action on organic compounds. As will be discussed in connection with the process, and as will be exemplified in detail hereinafter, the term metal-acid reducing agent combinations contemplated as metals, for example, zinc, iron, aluminum, tin, magnesium, and the like, and as acids, strong mineral acids such as, for example, hydrochloric acid and sulfuric acid, and monocarboxylic saturated open-chain aliphatic acids that have from 1 to 10 carbon atoms and which are soluble in the reaction system, such acids being represented by, for example, formic acid, acetic acid, isodecanoic acid, and the like.

The 2 - di-substituted-aminomethylpyromeconic acids may be conveniently prepared by reaction of pyromeconic acid with a mixture of formaldehyde and an organic amine such as, for example, dimethylamine, di-n-butylamine, piperidine, morpholine, and the like. Pyromeconic acid may be obtained as is described in the said copending application, for example, by decarboxylation of comenic acid which is in turn obtained by oxidation of commercially-available kojic acid. The reaction conditions suitable for formation of the Mannich base derived from piperidine are described in the aforementioned Spielman et al. article. However, as has been mentioned hereinbefore, since higher yields are obtained, it is preferred to employ the process of O'Brien et al. substituting instead an equivalent amount of pyromeconic acid for the kojic acid employed therein. As will be exemplified

in detail hereinafter, 2-morpholinomethylpyromeconic acid is obtained in very high yields, 92% of theoretical being easily achieved.

With respect to the improved process step contemplated by the instant invention, 2-di-substituted-aminomethylpyromeconic acid may be dissolved in water or in mixtures of water and other solvents such as lower alkanols, acetic acid, and the like; the mixture is treated with an amount of metal such as, for example, zinc, iron, aluminum, tin, magnesium, and the like, equivalent to from about 1.2 to about 2.5 gram atoms of metal per mole of Mannich base; the resulting suspension is treated with the acid member of the reducing agent combination and the reaction mixture is maintained at a temperature of from about 5° to about 125° C., preferably, to minimize side reactions, from about 25° to about 75° C., and especially preferably at about 55–65° C., until paper chromatographic assay indicates the 2-di-substituted-aminomethylpyromeconic acid to have been substantially completely consumed. Maltol can be isolated from the reaction mixture by adjusting the pH to from about 1 to about 3 and extracting the acidic solution with about 5 volumes of an organic solvent such as, for example, chloroform, ether, benzene, and the like. Concentration of the organic layer causes crystalline maltol to precipitate. This can be removed by filtration.

The metal to be employed in the improved process of the present invention must be appropriately located in the electromotive series to react with the acid member and provide the conditions required for reduction of the Mannich-base. Particularly useful for this purpose are zinc, iron, aluminum, tin and magnesium. It is especially preferred, because of its ready availability and low cost to use zinc. The form of the metal to be employed is not particularly critical to the invention. Thus the metal may be used in the form of chunks, granules or dust. However, it is especially preferred to employ zinc metal in the form of dust in this process since the reaction proceeds to completion in a relatively shorter time than if other forms are used.

The acid to be employed in the process of the present invention may be any strong mineral acid or monocarboxylic saturated open-chain aliphatic acids of from 1 to about 10 carbon atoms soluble in the reaction medium and capable of reacting with the metal and providing the conditions required for the reduction. While the exact mechanism of the reduction is not clearly understood, the interaction of metal with acid may furnish electrons needed for the reduction or alternatively, the combination of metal and acid may furnish an active form of hydrogen which may be involved in the reduction. Among the mineral acids which are particularly effective are hydrochloric and sulfuric and among the organic acids which are particularly effective are formic and acetic. It is especially preferred to use either hydrochloric acid or acetic acid in this reaction since the maltol formed has a tendency to be obtained in higher yield and in higher purity.

Of course, the instant invention is also to be understood to contemplate reduction of 2-di-substituted-aminomethylpyromeconic acids directly in solutions in which they are prepared by treatment of pyromeconic acid with formaldehyde and an amine. Thus the metal may be added to the reaction mixture, then the acid is added and the reduction is carried out as described hereinbefore and as exemplified hereinafter.

The following examples are illustrative of the process of this invention.

Example I

A mixture of morpholine, 35 g., 37% aqueous formaldehyde, 32.0 g., and ethanol, 400 ml., is allowed to stand for 15 minutes, then is stirred vigorously while pyromeconic acid, 33.6 g., is added during 5 minutes. Stirring is continued for an additional 16 hours and then the reaction mixture is cooled in an ice bath and the product is collected by filtration. There is obtained an 84% yield of 2-morpholinomethylpyromeconic acid, M.P. 150–151° C. An additional 8% yield of equally pure product is obtained after concentration of the filtrate to about one-fourth volume, cooling to 5° C. and collecting the crystals by filtration. The total yield of material is 92% of theory.

To a stirred suspension of 21.1 g. of the 2-morpholinomethylpyromeconic acid, zinc dust, 13 g., and water, 180 ml., is added 56 ml. of conc. hydrochloric acid at such a rate that the temperature is maintained between 60 and 65° C.; about 15 minutes are required. The mixture is then stirred for an additional 1.5 hours at 65° C.; during this time the reaction temperature is maintained by application of an external heating bath as necessary. The suspension is then heated to 90° C. and is filtered while hot to remove unreacted zinc metal. The filtrate is cooled to 30° C. and is adjusted to pH 2 by the addition of 50% aqueous sodium hydroxide solution. The solution is extracted with one-fifth volume of chloroform 6 times and the chloroform layer is concentrated to one-fourth volume and cooled. Crystalline maltol which precipitates is removed by filtration and weighs 4.44 g., 35% yield, M.P. 160–161° C. Concentration of the filtrate to one-third volume yields an additional 2.23 g., 17.7% yield of maltol, M.P. 159–161° C. A total yield of 53% is obtained.

The procedure is repeated substituting for the morpholine, stoichiometrically equivalent amounts of the following bases: piperidine, dimethylamine and di-n-butylamine. Substantially the same results are obtained.

Example II

The procedure of Example I is repeated substituting for the zinc dust, stoichiometrically equivalent amounts of the following metals: iron, aluminum, tin and magnesium. Substantially the same results are obtained.

Example III

The procedure of Example I is repeated substituting for the hydrochloric acid stoichiometrically equivalent amounts of the following acids: sulfuric, phosphoric, formic, acetic and isodecanoic. With the 10-carbon organic acid, it is desirable to add an appropriate quantity of isopropanol co-solvent to the predominantly aqueous system to promote solubility. Substantially the same results are obtained.

Example IV

A mixture of morpholine, 35 g., 37% aqueous formaldehyde, 32.0 g., and ethanol, 400 ml., is allowed to stand for 15 minutes, then is stirred vigorously while pyromeconic acid, 33.6 g., is added during 5 minutes; the mixture is stirred for an additional 16 hours. To this stirred suspension of 2-morpholinomethylpyromeconic acid is added 0.6 gram atoms of zinc metal dust, 500 ml. of water and then 150 ml. of concentrated hydrochloric acid is added at such a rate that the temperature is maintained between 60° and 65° C.; about 15 minutes are required. The mixture is then stirred for an additional 1.5 hours at 65° C.; during this time the reaction temperature is maintained by external heating. The suspension is then heated to 90° C. and is filtered while hot to remove unreacted zinc metal. The filtrate is cooled to 30° C., is adjusted to pH 2 by the addition of 50% aqueous sodium hydroxide solution and the maltol is extracted by the procedure of Example I. Substantially the same results are obtained.

The procedure of Example IV is illustrative of that embodiment of the instant invention wherein the improved process is applied to the reaction mixture in which the Mannich base is prepared.

What is claimed is:

1. In a process for the reduction of 2-di-substituted-aminomethyl pyromeconic acid Mannich bases to maltol,

the improvement which comprises treating the said 2-di-substituted-aminomethylpyromeconic acid Mannich base under reducing conditions with a metal-acid reducing agent combination.

2. A process as in claim 1 wherein the said 2-di-substituted-aminomethylpyromeconic acid Mannich base is 2-morpholinomethylpyromeconic acid Mannich base.

3. A process as in claim 1 wherein the said 2-di-substituted-aminomethylpyromeconic acid Mannich base is 2-piperidinomethylpyromeconic acid Mannich base.

4. A process as in claim 1 wherein the said metal agent is zinc and the said acid agent is hydrochloric acid.

5. A process as in claim 1 wherein the said metal agent is zinc and the said acid agent is acetic acid.

References Cited in the file of this patent

Spielman et al.: Journal American Chemical Society, vol. 69, pp. 2908–2909 (1947).

O'Brien et al.: Journal Organic Chemistry, vol. 25, pp. 86–89 (1960).

Campbell et al.: Journal Organic Chemistry, vol. 15, pp. 221–226 (1950).

Fieser et al.: Advanced Organic Chemistry, page 114, Reinhold Publishing Corp., New York (1961).

United States Patent Office

3,186,853
Patented June 1, 1965

3,186,853

METHOD OF PROCESSING MEAT

Jerome A. Meusel, Baltimore, Md., assignor to The Baltimore Spice Company, Baltimore, Md., a corporation of Maryland

No Drawing. Filed Sept. 3, 1964, Ser. No. 394,325
2 Claims. (Cl. 99—159)

This application is a continuation-in-part of my copending application Serial No. 195,008, filed May 15, 1962, and now abandoned.

This invention relates to seasoning, curing, and pickling of meats, fowl, and fish and to edible foodstuffs manufactured therefrom and particularly to means providing for the identification of seasonings, cures, and pickling compositions utilized in the processing of foodstuffs in accordance with the present invention.

In the preparation of seasoned foodstuffs on a commercial scale a large number of spices and seasonings are added to the meat, fish, or fowl being processed, or to the cure or pickle liquor with which the foodstuff is sometimes treated. Even with the most careful proportioning and blending it is a not uncommon occurrence that some one flavor or curing effect predominates or is lacking in the final product to an undesirable extent, possibly because of segregation or uneven distribution of the seasoning throughout the foodstuff or because of improper usage or substitution. For these reasons, or others, a more or less average percentage of processed foodstuffs are returned to the food processor as defective or unsatisfactory by the purchaser.

Usually the food processor has no recourse except to reimburse the purchasers although in many instances, he is not at all certain that the allegedly unsatisfactory products originated from him at all. As a consequence, from the standpoint of the food processor, it would be very desirable to be able to identify the foodstuffs originating at his plant in some non-toxic and inconspicuous manner.

Briefly, the present invention comprises the addition of small but significant amounts of maltol to the seasonings, cures, or pickling compositions used in the processing of edible foodstuffs being processed, whereby the resulting products may be readily distinguished from similar foodstuffs to which maltol has not been added. By incorporating the maltol in suitable amounts and at appropriate stages in the processing, foodstuffs are produced which may be readily identified as those to which maltol has been added.

Specifically, it has been found that by incorporating maltol into seasonings, cures, or meat pickles for food products, in various amounts such that from 0.25 to 2.5 parts per million of maltol remains in the finished food product, the desired identification can be obtained.

The following are formulas for sesonings, meat pickles, and other meat curing ingredients as examples of food components to which maltol has been added so that the desired amount of maltol results in the finished food product.

Chicken seasoning (for chicken broth, chicken rice soup, chicken noodle soup, chicken Brunswick stew, chicken pie, chicken gravy, etc.)

Monosodium glutamate	pounds	20
Dextrose	do	30
Onion powder	do	3
Ground white pepper	pound	1
Ground celery seed	do	1
Salt	pounds	45
Maltol	ounce	.08

Directions: Use 8 oz. of above seasoning to 100 lbs. of chicken product.

Frankfurter seasoning

Ground coriander	pounds	67
Ground nutmeg	do	15
Ground white pepper	do	10
Ground paprika	do	5
Ground ginger	do	2
Ground cardamom	pound	1
Maltol	ounce	.32

Directions: Use 8 oz. of above seasoning to 100 lbs. of frankfurter product.

Pork sausage seasoning

Salt	pounds	60
Cane sugar	do	15
Rubbed sage	do	10
Ground black pepper	do	10
Ground ginger	do	3
Ground marjoram	pound	1
Ground thyme	do	1
Maltol	ounce	.16

Directions: Use 2 lbs. of above seasoning to 100 lbs. of pork sausage.

Meat loaf seasoning

Dextrose	pounds	98
Oleoresin of black pepper	pound	1
Oleoresin of paprika	ounces	2
Oil of cloves	do	8
Oil of pimenta berries	do	4
Oil of cinnamon	do	2
Maltol	ounce	.16

Directions: Use 8 oz. of above seasoning to 100 lbs. of meat loaf.

Pumping or cover pickle cure

Salt	pounds	86
Sodium nitrite	do	6
Sodium nitrate	do	4
Maltol	pound	.045

Directions: Use according to the following formula.

Water	gallons	50
Salt	pounds	75
Sugar	do	15
Cure as above	do	15

Pump hams 10% of green weight.

Phosphate compound for pumping pickle

Sodium acid pyrophosphate	pounds	40
Tetra sodium pyrophosphate	do	40
Sodium tripolyphosphate	do	20
Maltol	pound	.05

Directions: Use 2 to 6 oz. per gallon of pickle.

As indicated above, it is highly desirable to be able to identify the food products after they have left the control of the food processor and entered into channels of trade, since complaints are received from time to time from customers that a seasoning, cure, meat pickle, or the like has been responsible for the production of an unsatisfactory product. Usually, there is no means of determining whether the specific products which have been used, originated with a specific food processor, or a specific supplier of the seasoning, cure, or pickle, or if they did, whether they have been used in the proper amounts according to instructions.

Various types of invisible markers are employed by manufacturers for the purposes of identification but they have certain disadvantages. Some are easily detected by odor and flavor. Others, are toxic or are not approved as food additives under the Additives Amend-

ment to the Food, Drug and Cosmetic Act. Still others are not sufficiently sensitive to be able to positively identify the seasoning, cure, meat pickle, etc. in the finished product.

One important aspect of the present invention is that it provides a means whereby seasonings and the like can be identified in a finished food product easily and positively even at great dilutions.

As indicated in the formulations above, maltol is added to seasonings and pickle cures in amounts which will result in traces being present in the finished food product and which are not toxic and do not impart an objectionable flavor or odor to the food. Amounts in the range of 0.25 part per million or more are satisfactory, and may be readily detected in the edible product.

The above amounts are not to be confused with the presently used amounts of maltol when it is used as a flavorant or to enhance flavors in foodstuffs. In such instances the maltol is usually added as a separate addition and in amounts of from 30 to 3300 parts per million of food, upwards of 100 p.p.m. being the amounts usually employed, the addition of maltol being such as to provide between 0.25 and 2.5 parts per million of maltol in the foodstuff and between 50 and 500 parts per million of maltol in the additive to be incorporated into the foodstuff.

The identification of maltol in the food product is achieved as follows:

A sample of the seasoning, cure, meat pickle, finished food product, etc. is extracted using distilled water. A minimum amount of water is used so that slightly more than 20 milliliters of extract is obtained.

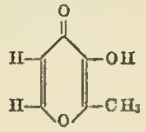
Two 10 milliliter sample portions are taken of the extract and 10 milliliters of distilled water is added to one and 2 milliliters of 2 N sodium hydroxide and 8 milliliters of ferric ammonium sulfate solution are added to the other. The ferric ammonium sulfate solution is prepared by weighing 20 grams of $FeNH_4(SO_4)_2 \cdot 12H_2O$ into a 2 liter flask and adding 500 milliliters of distilled water and then 45 milliliters of concentrated sulfuric acid. The reagent is then diluted to 2 liters with distilled water.

Even though the extract of seasoning, cure, meat pickle or finished food may be colored, in most cases a difference in color between the extract of the sample without ferric ammonium sulfate and the sample with ferric ammonium sulfate is immediately apparent.

If there is no apparent difference in color, the samples of extract are transferred to cuvettes with a 1 centimeter light path and the light absorbency is determined at 520 millimicrons in a Model DB Beckman Spectrophotometer or similar instrument. Any increase in the absorbency at this wavelength in the sample with the ferric ammonium sulfate solution as compared to the sample without the ferric ammonium sulfate solution, indicates the presence of maltol and this indicates the presence of the marked seasoning, cure, or meat pickle, and hence identifies the seasoning, cure, or meat pickle.

By developing appropriate spectrophotometric curves for maltol for various amounts of maltol originally introduced into the seasoning, cure or meat pickle, it is possible to determine in the finished food product whether the seasoning, cure or pickle had been used in the amount recommended to the food processor or whether the finished food product was deficient or contained an excess of the seasoning.

Maltol is available as a dry, white fine powder and is sufficiently soluble that it is readily taken up in seasoning or cures of the type described. Maltol is also known as the compound represented by the formula



Having now described the invention in its preferred aspects, it is not intended that it be limited except as required by the appended claims.

I claim:

1. In the seasoning of meat products formed from comminuted meats, the improvement which permits identification of the source of the seasoning incorporated in the comminuted meat product which improvement consists in incorporating into the seasoning an amount of maltol and incorporating said maltol-containing seasoning into the comminuted meat in an amount such that the amount of maltol imparted to the seasoned meat product is substantially below an amount which suffices to impart a noticeable maltol flavor to said meat product and which constitutes between about 0.25 part and 2.5 parts per million of maltol in said meat product.

2. In the curing of meat products the improvement which permits identification of the source of the curing composition used in the curing process which improvement consists in incorporating into the curing composition an amount of maltol and incorporating said curing composition into the meat to be cured, under conditions such that the amount of maltol imparted to the cured meat product is substantially below an amount which suffices to impart a noticeable maltol flavor to said cured product and which constitutes between about 0.25 part and 2.5 parts per million of maltol in said cured product.

References Cited by the Examiner

UNITED STATES PATENTS

2,355,548	8/44	Musher	99—109
2,860,995	11/58	Sair	99—140 X
2,937,094	5/60	Rupp et al.	99—159
2,955,041	10/60	Broderick et al.	99—107 X
3,032,421	5/62	Buchholz	99—109
3,156,569	11/64	Griffin et al.	99—140

A. LOUIS MONACELL, *Primary Examiner.*

HYMAN LORD, *Examiner.*

United States Patent Office 3,293,045 Patented Dec. 20, 1966

3,293,045

INCREASING THE FLAVOR STRENGTH OF ANETHOLE, CINNAMALDEHYDE AND METHYL SALICYLATE WITH MALTOL

Joan M. Griffin, Forest Hills, N.Y., assignor to Chas. Pfizer & Co., Inc., New York, N.Y., a corporation of Delaware

No Drawing. Filed Oct. 18, 1963, Ser. No. 317,126
3 Claims. (Cl. 99—134)

This application relates to new and novel flavoring compositions. More particularly, it concerns compositions comprising aromatic flavoring ingredients together with maltol, a gamma-pyrone. There are also contemplated foods, beverages, candy and tablets, syrups, medicinal oils, pill and tablet coatings and troches containing these flavoring compositions.

Among the most useful items of commerce are natural and synthetic flavors of the type represented by anise, cinnamon and wintergreen. These flavor essences, which provide the well known flavors of licorice, cinnamon and wintergreen, respectively, are widely employed in the manufacture of food, beverages and candy. In addition, the pharmacist has found them to be very useful in compounding prescriptions. For example, the above-mentioned flavors, properly selected, are commonly employed for disguising salty or bitter and even nauseating medicines, which aids in the ingestion of the medicine by the patient.

A further use for these flavors, which is not particularly widely known, is to employ them as therapeutic agents. Thus, for example, both anise oil and wintergreen oil have long been known to be carminatives and cinnamon is often prescribed for the treatment of nausea and diarrhea. As with any therapeutic agent, the use of these materials in large quantities requires careful supervision by a physician so that problems of overdosages or adverse side reactions are minimized. Furthermore, one of them, wintergreen oil, has long been recognized as being toxic in large amounts. Because wintergreen oil smells like wintergreen candy, it is frequently ingested by children and has caused many fatalities.

Because of the physiological effects caused by ingestion of relatively large quantities of the active principles of anise, cinnamon and wintergreen oils, the governmental regulatory agencies responsible for controlling the permissive levels for all such materials in preparations manufactured for internal consumption are continually reviewing their employment. Recently, the tendency is for regulations to be issued which decrease the amount of such flavoring chemicals which may be used in materials to be ingested. For example, wintergreen oil is the subject of a proposed regulation which may limit the maximum amount to be employed to the neighborhood of about 300 parts per million in candy. Since the levels now used are commonly of the order of 600 to 8000 parts per million, it is seen that the characteristic flavor of ingestibles prepared with oil of wintergreen will be altered as the materials are compounded to accord with the regulations.

It has now been found that it is possible to decrease the amount of the flavoring compound added to ingestibles, such decrease being of the order of about one half or even less of the original material used, while at the same time maintaining the desirable and important flavoring and flavor disguising effects of the flavorants.

It is a principal object of the instant invention to provide a flavoring composition which may be added to ingestibles in lower effective minimum quantities than have previously been employed heretofore.

It is a further object of the instant invention to provide wintergreen-flavored candies which contain as their main flavoring ingredient wintergreen oil in lower minimum effective levels than have previously been employed.

These and other objects are readily achieved through use of the compositions of the instant invention which are, in essence: A flavoring composition comprising an agent selected from the group consisting of anethole, cinnamaldehyde and methyl salicylate and from about 15% to about 100% by weight thereof of maltol.

The instant invention contemplates the use of both natural and synthetic anise, cinnamon and wintergreen oils. It contemplates their use in the form of pure oils or blends of pure oils prepared either synthetically, being obtained by chemical reaction and distillation or, naturally, being obtained by extraction from the plant material from which the subject oils have been classically isolated. Generally speaking, the natural oils will, as described hereinafter, comprise predominantly one chemical entity together with isomers of this entity and minor amounts of various other compounds.

The following descriptions of the flavoring oils of the instant invention are taken from Remington's Practice of Pharmacy, Mack Publishing Co., 1961.

Anise oil is the volatile oil distilled with steam from the dried fruit *Pimpinella anisum* Linne or from the dried fruit of *Illicium verum* Hooker *filius*. It is used extensively as a flavoring agent, particularly for licorice candies and, as mentioned hereinbefore, it is often prescribed as a carminative. Carminatives are substances which relieve gaseous distention of the stomach or intestines. The chief constituent of anise oil is anethole, also known as para-propenyl anisole, which is present naturally to the extent of about 80 to 90%. The synthetic anise oil contemplated by the instant invention is the aforesaid anethole, also known as para-propenyl anisole.

Cinnamon oil is the volatile oil distilled with steam from the leaves and twigs of *Cinnamomum cassia* Nees ex Blume, rectified by distillation. It is comprised of not less than 80% by volume of aldehydes. Cinnamon oil is used as a flavor and to modify the action of gripping or drastic drugs. It is used in the treatment of flatulent colic. The synthetic cinnamon oil contemplated by the instant invention is cinnamaldehyde, which is often used to replace the natural oil as a flavor.

Wintergreen oil is obtained by maceration of the leaves of *Gaultheria procumbens* Linne or the bark of *Betula lenta* Linne and subsequent distillation with steam. It is comprised almost completely of methyl salicylate. In addition to its use as a flavoring agent, methyl salicylate is used in the treatment of rheumatism, neuralgia and kidney diseases and is used as a carminative. The synthetic wintergreen oil contemplated by the instant invention is methyl salicylate which may be made, for example, by treatment of salicylic acid with methyl alcohol in the presence of sulfuric acid and distilling.

By the term foods are used herein and in the appended claims, it is meant to contemplate breads, cakes, pastries and frostings, and the like, in which the synthetic flavors are commonly employed. The term beverages contemplates, for example, soft drinks, punches, fruit juices, wines and liqueurs, and the like, in which these flavors are commonly employed. The term candy contemplates fruit drops and chocolate covered confections, hard, soft and chewy confections, including chewing gum and syrups, and the like. Pharmaceutical applications include compounded tablets, syrups, medicinal oils, coatings for pills and tablets and troches. A troche is a dosage form which is dissolved in the oral cavity slowly releasing the medicament contained therein.

While up until now the flavoring oils under consideration have been employed at levels of up to about 8000

parts per million and even more based on the product to be ingested, it is found that the content of the flavoring oil may be reduced to from about 50 to 300 parts per million based on the material to be flavored. In addition to providing for the ingestion of smaller quantities of the flavoring ingredient with the therapeutic activity mentioned hereinbefore, the instant invention also provides for a possible saving in the cost of some of the more expensive ingredients since less of the ingredient is required to give the desired flavor. It has been found that if a level of below about 50 parts per million of flavoring oil is used, the average test subject begins to find it difficult to appreciate the desired flavor. If, on the other hand, amounts of above about 300 parts per million of anise oil, cinnamon oil and wintergreen oil are used, it is obvious that the material to be ingested will contain more of the flavoring ingredient than it is anticipated will be permissible under the proposed federal regulations.

At the 50 to 300 parts per million level of the said flavoring oils, in the absence of maltol, relatively weak flavor strength is noted by those tasting the representative flavored confections, beverages and medicinal oils. It is found, however, that if there is added from about 15% to about 100% of maltol by weight based on the normally ineffective amount of said flavoring oil, the flavor receives such a boost that the test subjects find it difficult to distinguish over effects which are achieved only with amounts of the flavoring oil from about 600 to 800 parts per million and even more. In creme center candy, for example, it is found that 300 parts per million of methyl salicylate plus 100 to 125 parts per million of maltol is approximately equal in flavor strength to 600 to 800 parts per million of methyl salicylate alone.

As is well known, the flavoring agents which may be used in this invention are conveniently employed in vehicles consisting of solutions of the pleasantly flavored volatile oils in syrup or glycerin. A composition of about 1 part of oil per 500 parts of glycerine produces a particularly useful and stable preparation for pharmaceutical flavoring purposes. To make up such a vehicle, the compounder conveniently adds 2 ml. of the volatile oil, diluted with 6 ml. of alcohol to 500 ml. of glycerin or syrup which has been gently warmed. The solution is added a little at a time, with continuous shaking, and then sufficient glycerin or syrup is added to make 1000 ml. and mixed well. According to the present invention, a vehicle containing the volatile oil together with maltol is made by cutting back of the oil to about 1 ml., or other desired level, adding maltol in an amount of from about 15% to about 50% of the weight of the oil taken and compounding as outlined above. These vehicles may be kept in stock and used as the basis for prescribed medicines, the proper flavor being chosen in accordance with practices known to those skilled in the art or outlined in reference works such as Remington's Practice of Pharmacy.

The following specific examples illustrate the practice of the invention, but are not to be construed as limiting the scope of the invention in any way whatsoever.

Example I

A basic fondant plastic creme center formula for candy is prepared: In a vessel are placed 8 lbs. of granulated sugar, 2 lbs. of corn syrup, 1 lb. of invert sugar and enough water to dissolve the sugar. All of the ingredients are then heated together, stirring the batch occasionally until it boils. Any sugar grains which adhere to the vessel walls are washed down and the batch is heated until the temperature of the boiling mass reaches 240° F. The mixture is poured onto a clean, wet slab and is cooled to about 110° F. When it has reached this temperature it is creamed with a spatula and is stored until used.

Five batches of the fondant are mixed with methyl salicylate until there are obtained, respectively, one batch each with 50, 150, 300, 500 and 800 p.p.m. of methyl salicylate. Each of the batches containing methyl salicylate at 50, 150, 300 and 500 p.p.m. is itself divided into five batches. One of the batches containing 50 p.p.m. of methyl salicylate is left untreated and to the other four are added, respectively, enough maltol to provide batches containing 50, 75, 100 and 125 p.p.m. of maltol. These five batches are tasted by a panel and the flavors compared. It is found that the wintergreen flavor of all samples containing maltol is greater than the wintergreen flavor of the sample which does not contain maltol.

One of the batches containing 150 p.p.m. of methyl salicylate is treated with enough maltol to provide 100 p.p.m.; one of the batches containing 300 p.p.m. of methyl salicylate is treated with enough maltol to provide 100 p.p.m. A taste panel evaluation of these three blends is made and compared with the taste of fondant samples flavored with 300 p.p.m., 500 p.p.m. and 800 p.p.m. of methyl salicylate and to which no maltol has been added. The wintergreen taste with 150 p.p.m. of methyl salicylate and 100 p.p.m. of maltol is significantly greater than that of 150 p.p.m. of methyl salicylate alone but less than that of 300 parts of methyl salicylate alone; the wintergreen flavor with 300 p.p.m. of methyl salicylate and 125 p.p.m. of maltol is greater than that of 500 p.p.m. of methyl salicylate alone and less than that of 800 p.p.m. of methyl salicylate alone; and the flavor of 500 p.p.m. of methyl salicylate and 100 p.p.m. of maltol is also greater than 500 p.p.m. of methyl salicylate alone but less than that of 800 p.p.m. of methyl salicylate alone. Thus, it is clearly demonstrated that the flavor strength of 300 p.p.m. of methyl salicylate plus 125 p.p.m. of maltol (or 42% of maltol based on the methyl salicylate) is approximately equal to from at least 500 to about 800 p.p.m. of methyl salicylate alone. Furthermore, it is found that an appreciable boost in the wintergreen flavor is provided by maltol in amounts ranging from about 20% (500 p.p.m. of methyl salicylate with 100 p.p.m. of maltol) to 100% and even higher (50 p.p.m. of methyl salicylate with 50 p.p.m. of maltol based on the methyl salicylate).

Example II

A liqueur base is prepared by mixing together 4550 ml. of ethyl alcohol (90%), 5150 ml. of water and 400 ml. of a normal syrup. The normal syrup is prepared by boiling a mixture of 2 parts granulated sucrose and 1 part of water until the initial volume is reduced by one-third.

An anisette-type liqueur is prepared by adding anethole, also known as p-propenyl anisole, to a portion of the liqueur base in an amount sufficient to provide a concentration of 500 p.p.m. This is used as a basis of flavor strength evaluation in comparison with a series of liqueurs prepared by adding anethole and maltol to the liqueur base. It is found that 500 p.p.m. of anethole and 75 p.p.m. of maltol provide a flavor equivalent stronger than 500 p.p.m. but less than 800 p.p.m. of anethole alone. Furthermore, 300 p.p.m. of anethole and 125 p.p.m. of maltol provides a flavor strength very much greater than 500 p.p.m., but slightly less than 800 p.p.m. of anethole alone. The use of 150 p.p.m. of anethole with 100 p.p.m. of maltol provides a flavoring strength very much greater than 150 p.p.m. and only slightly less than 300 p.p.m. of anethole alone.

These results indicate that flavor levels equivalent to that produced by nearly 300 p.p.m. of anethole alone can be obtained with approximately ½ this amount of anethole if about 67% of maltol, based on the oil is added. Furthermore, if the amount of anethole is reduced by 40%, then 42% of maltol based on the remaining oil is sufficient to boost the flavor equivalency to that of the basic liqueur, which contains 500 p.p.m.

Example III

A hard candy cough drop base is prepared by melting 10 lbs. of granulated sugar down with 0.4 gallon of water in a kettle. The mixture is heated to about 160° C. then is cooled to 135° C. and is divided into portions. To one portion is added cinnamaldehyde in an amount to provide 500 p.p.m. and the mass is mixed well, rolled and cut into drops. To other portions are added cinnamaldehyde and maltol in measured amounts and drops are prepared. The drops are tasted and the flavor strengths are compared. It is found that the addition of 100 p.p.m. of maltol to the 500 p.p.m. of cinnamaldehyde containing base provides a flavor strength greater than 500 p.p.m. but less than that equivalent to 800 p.p.m. of cinnamaldehyde alone. A base containing 300 p.p.m. of cinnamaldehyde and 125 p.p.m. of maltol has a flavor equivalent very much greater than 500 p.p.m. but less than 800 p.p.m. of cinnamaldehyde alone. A base containing 150 p.p.m. of cinnamaldehyde and 100 p.p.m. of maltol has a flavor strength very much greater than 150 p.p.m. but less than p.p.m. of cinnamaldephyde alone.

These results show that the amount of cinnamaldehyde required to give a flavor equivalent to that of nearly 300 p.p.m. is only 150 p.p.m. if an amount of maltol equivalent to about 67% of the remaining cinnamon oil is provided.

What is claimed is:

1. A method for flavoring foodstuffs and medicines which comprises incorporating therein from about 50 to about 300 parts per million of an agent selected from the group consisting of anethole, cinnamaldehyde, and methyl salicylate and from about 15% to about 100% of maltol by weight of said agent.

2. A method for flavoring foods, candy, tablets, syrups, medicinal oils, pill and tablet coatings and troches which comprises incorporating therein from about 50 to about 300 parts per million of methyl salicylate and from about 15% to about 100% of maltol by weight of said methyl salicylate.

3. A wintergreen-flavored candy which contains at its main flavor-imparting ingredients from about 50 to about 300 parts per million of methyl salicylate and from about 15% to about 100% of maltol by weight of said methyl salicylate.

References Cited by the Examiner

UNITED STATES PATENTS

3,015,654	1/1962	Hodge et al.	99—140 X
3,130,204	4/1964	Tate et al.	99—140 X
3,159,652	12/1964	Tate et al.	99—140 X

A. LOUIS MONACELL, *Primary Examiner.*

JOSEPH M. GOLIAN, *Examiner.*

United States Patent Office

3,296,079
Patented Jan. 3, 1967

3,296,079

PRODUCTS SWEETENED WITHOUT SUGAR AND CHARACTERIZED BY FREEDOM FROM AFTERTASTE

Joan M. Griffin, Forest Hills, N.Y., assignor to Chas. Pfizer & Co., Inc., New York, N.Y., a corporation of Delaware

No Drawing. Filed Dec. 9, 1963, Ser. No. 329,244
4 Claims. (Cl. 167—93)

This invention relates to sweetened products and to processes for the preparation thereof. More particularly, it is concerned with products containing in combination non-nutritive sweetening agents and an aftertaste-masking amount of maltol.

The products contemplated by this invention comprise a number of comestibles and other substances in which non-nutritive sweetening agents are used. Foods, such as canned fruits, gelatin desserts, carbonated beverages, dietetic candies, jams, jellies, frozen desserts, and the like, oral cleaning agents, such as toothpastes, powders and mouth washes, comestics, medicinal preparations and tobacco are examples of products in which non-nutritive sweetening agents are commonly used.

Maltol, also known as 2-methyl-3-hydroxy-4-pyrone, is a gamma-pyrone of rapidly increasing acceptance for enhancement of odors and flavors of many products. For example, as is disclosed in the copending patent application, Serial No. 310,155, filed September 19, 1963, and assigned to the assignee of the instant application, maltol has been found, surprisingly, to enhance the apparent sweetness of natural sugars. Thus, as is disclosed in the said copending application, part of the natural sugar in many products may be replaced with relatively very much smaller amounts of maltol. In marked contrast, it has now been found that maltol does not exhibit a sweetness-enhancing effect with non-nutritive sweetening agents as is observed with natural sugars such as sucrose, dextrose, glucose, and the like. Furthermore, while not enhancing the sweetness of non-nutritive sweetening agents, maltol has been found to mask the bitter and metallic aftertastes commonly associated with the use of said agents. This masking effect is surprising in view of the use of maltol as an enhancer. The present invention is concerned with this newly-discovered use of maltol to mask the unpleasant aftertaste associated with the use of non-nutritive sweetening agents.

Among the non-nutritive sweetening agents contemplated by the instant invention are, for example, cyclohexylsulfamic acid, saccharin, xylitol, arabitol, perillartine, stevioside, and physiologically-acceptable salts of those agents capable of forming salts.

It is a matter of common knowledge and experience that the said non-nutritive sweetening agents above-mentioned provide a bitter note in excessive concentrations. Some users, in addition, observe that a metallic aftertaste is imparted to products in which the said agents are used. Furthermore, it is well established that the threshold for bitterness varies with individuals. For the majority of the population, this threshold, which is indicated to be of the order of 0.1% with saccharin and approximately 0.8% with cyclohexylsulfamic acid salts, is well above the level of ordinary use. However, even with expediencies such as the use of combinations of cyclohexylsulfamic acid salts and saccharin, it is still significant that aftertaste is experienced by a considerable percentage of the population. Futhermore, from the standpoints of ease of formulation and some state regulations, it is not always feasible to use saccharin in combination with cyclohexylsulfamic acid in certain products. As a result, significant proportions of the population in certain areas experience aftertaste, particularly in carbonated beverages which are sweetened solely with cyclohexylsulfamic acid salts.

In addition to aftertastes associated with the use of saccharin and cyclohexylsulfamic acid and their salts, it is noted that such aftertastes are observed following the use of other non-nutritive sweetening agents such as arabitol, also known as 1,2,3,4,5-pentanepentol, xylitol, an isomer of arabitol, and stevioside, an isolate of the plant, *Stevia rebaudiana*, and many others.

It has now been found that the use of an aftertaste-masking amount of maltol with products sweetened with non-nutritive sweetening agents provides highly acceptable products when tasted by a number of different individuals. These said products are chaarcterized by a complete lack of bitter and metallic flavors and are much more acceptable than the same products sweetened with the non-nutritive sweetening agents to which maltol has not been added.

It is, therefore, a principal object of the instant invention to provide an improved method for sweetening products with non-nutritive sweetening agents whereby they are made more widely acceptable. It is a further object of the instant invention to provide comestibles sweetened with non-nutritive sweetening agents, said comestibles being free of bitter and metallic aftertastes.

These and other objects of the instant invention are readily achieved through practice of the following process: In a method for sweetening products, the improvement which comprises masking the unpleasant aftertaste of non-nutritive sweetening agents by incorporating with said sweeteners maltol in an amount to provide from about 0.003 to about 160% by weight based on said sweetening agent.

The instant invention contemplates, in addition to the said process, comestibles containing in combination a non-nutritive sweetening agent characterized by a bitter and metallic aftertaste and an aftertaste-masking amount of maltol. Furthermore, it contemplates oral cleaning agents containing in combination a non-nutritive sweetening agent characterized by a bitter and metallic aftertaste and an aftertaste-masking amount of maltol.

With respect to the amount of maltol required to mask the bitter aftertaste, it is found that maltol in an amount to provide from about 0.003 to about 160% by weight, based on the non-nutritive sweetening agent, is effective. Below about 0.003% of maltol, with sweeteners of low strength relative to sucrose, such as arabitol and xylitol, some of the subjects begin to have difficulty in recognizing its beneficial effect and above about 160% with the most powerful sweeteners such as perillartine, maltol begins to contribute a flavor note of its own. On another basis, the effective amount of maltol can be computed, based on the weight of the product sweetened with non-nutritive sweetening agent; generally speaking, maltol is found effectively to mask the aftertaste when it is present in an amount to provide from about 5 to about 400 parts per million (p.p.m.) based on the said sweetened product. As will be well understood by those skilled in this art of product formulation, the aftertaste-masking amount of maltol readily may be found by adjusting the concentration within the stated ranges. The proper amount will depend on the nature of the product and the amount of sweetener used. Higher amounts of maltol are required

if a particularly bitter ingredient such as stannous fluoride, commonly employed in toothpastes, is to be masked with the sweetening agent. Lesser amounts of maltol are required if only small amounts of non-nutritive sweetening agents are added to products, such as canned fruits, which contain natural sugars. Generally, 30 p.p.m. of maltol has been found effectively to mask the bitter cyclamate flavor of a commercial sweetening preparation, for table use, which contains about 6% by weight of calcium cyclohexylsulfamate; this represents an amount of maltol to provide about 0.05% by weight based on said sweetener. Furthermore, dietetic syrups such as cherry-cola, grape, orange and raspberry, sweetened with non-nutritive sweetening agents are freed of aftertaste by adding 25 and 50 p.p.m. of maltol; since these syrups typically contain about 0.4% by weight of said sweeteners, this represents an amount of maltol sufficient to provide from about 0.62 to about 1.25% by weight based on said sweetener. Low-calorie carbonated beverages are freed of aftertaste by adding from about 5 to about 30 p.pm. of maltol; since these ordinarily contain about 0.25% by weight of said sweeteners, this represents an amount of maltol sufficient to provide from about 0.2 to about 1.2% by weight based on said sweetener.

As specific embodiments of the instant invention, special mention is made of the increase in mildness obtained if, in addition to maltol, an amount of from about 0.2 to about 15 parts, based on each part of the sweetening agent, of a polyhydric alcohol such as propylene glycol, glycerol or sorbitol is added. Products with very desirable mildness and freedom from aftertaste and bitterness are thus obtained, as will be exemplified more fully hereinafter, by combining non-nutritive sweetening agents, polyhydric alcohols and maltol; these are especially useful for table use when it is desired to sweeten, for example, coffee and tea or grapefruit or other comestibles.

The following examples are illustrative of the process of the instant invention and of the products obtainable therewith. They are not to be construed as being limiting in any manner.

Example I

Sodium saccharin is added to water in an amount to provide 0.1% by weight. Sodium saccharin is about 500 times as sweet as sugar. The solution has a disagreeable metallic aftertaste. Maltol is added in increments to provide 5, 10, 20, 30, 40, 100, 200, 300 and 400 p.p.m., respectively. The solution is tasted after each addition and it is found to be free of aftertaste when it contains between 5 and 400 p.p.m. of maltol. Maltol has thus been added effectively in an amount to provide from about 0.5 to about 4% by weight based on said saccharin.

The procedure is repeated substituting for 0.1% of sodium saccharin, 1.05% of calcium cyclohexylsulfamate, also known as calcium cyclamate. Calcium cyclohexylsulfamate is about 30 times as sweet as sucrose. It is found that the bitter aftertaste associated with this concentration of this non-nutritive sweetening agent is masked by the addition of maltol in an amount to provide from 5 to 400 p.p.m. by weight based on the aqueous solution; this is an amount of maltol sufficient to provide from about 0.05 to about .38% by weight based on said sweetener.

The procedure is repeated substituting a 0.166% aqueous solution of stevioside, a non-nutritive sweetening agent derived from a plant, for the 0.1% saccharin solution. Stevioside is about 300 times as sweet as sucrose. The aftertaste of this agent is masked by the addition of maltol in an amount to provide from 5 to 400 p.p.m. by weight based on the aqueous solution; this is an amount of maltol sufficient to provide from about 0.3 to about 2.4% by weight based on said sweetener.

The procedure is repeated substituting for the 0.1% solution of saccharin, respectively, the following aqueous solutions: 0.025% perillartine, also known as 1-perillaldehyde α-antioxime, which is 2000 times as sweet as sugar, and 15% solutions of xylitol and of arabitol. In all cases the aftertastes of these non-nutritive sweetening agents are masked by from 5 to 400 p.p.m. of maltol. The amount of maltol used with perillartine is from about 2 to about 160% by weight based on said sweetener; the amount of maltol used with xylitol and arabitol is from about .003 to about 0.26% by weight based on said sweetener.

Example II

A raspberry-flavored dietetic syrup simulating a 40% sugar-containing syrup, but containing no sugar, is formulated:

	Grams
Soluble saccharin	0.08
Carboxymethylcellulose	0.30
Sodium cyclamate	0.30

Water to make a total volume of 100 ml.
Raspberry flavoring.

The syrup is charcterized by a bitter and metallic aftertaste. Maltol in an amount to provide 25 p.p.m., based on the syrup, or 0.66% based on the combined weight of the non-nutritive sweetening agents, masks the aftertaste. Similarly, cherry-cola, grape and orange-flavored syrups are prepared. The aftertaste is effectively masked with 25 and 50 p.p.m. of maltol in the cherry-cola flavored syrup, with 50 p.p.m. of maltol in the grape flavored syrup and with 50 p.p.m. of maltol in the orange flavored syrup.

Example III

A carbonated black cherry-flavored beverage is formulated:

	Grams
Sodium cyclohexylsulfamate	0.25
Methyl cellulose	0.08
Pectin	0.009

Water, 100.0.
Black cherry flavor, minor proportion.

This beverage has a distinct, bitter aftertaste. This aftertaste is muted by the addition of maltol in an amount to provide 20 p.p.m., based on the beverage. This is equivalent to 0.8% of maltol based on the non-nutritive sweetening agent.

Similar beverages were prepared with different flavors; 20 p.p.m. of maltol masked the bitter non-nutritive sweetening agent taste in black raspberry-, orange-, root beer-, grape-, and lemon-flavored dietetic carbonated beverages.

Example IV

To a carbonated black cherry-flavored beverage formulated as in Example III is added sorbitol in an amount to provide 1.3 grams per 100 grams of beverage. This amount corresponds to 5.2 parts of sorbitol per part of non-nutritive sweetening agent. Maltol is present in an amount to provide 20 p.p.m. based on the beverage. The beverage was characterized by a freedom from bitter and metallic aftertaste and the sorbitol addition provides a milder, sweeter, and blander tasting beverage than does maltol alone, without sorbitol.

Example V

A commercial fluoride-containing (0.5% by weight of stannous fluoride) toothpaste containing 1.0% by weight of calcium cyclohexylsulfamate is characterized by a bitter and metallic aftertaste. This aftertaste is effectively muted by incorporating maltol in an amount to provide 200 p.p.m. based on the said toothpaste; this is an amount of maltol sufficient to provide 2% by weight based on said sweetening agent.

Example VI

The following tabulated mixtures were prepared:

PARTS BY WEIGHT

Propylene Glycol	Sorbitol	Glycerol	Calcium Cyclamate	Sodium Saccharin	Water
25	------	--------	1	1	73
25	------	--------	1	10	64
25	------	--------	1	25	49
25	------	--------	5	4	66
25	------	----------	10	4	61
--------	25	--------	1	1	73
--------	25	--------	1	10	64
--------	25	--------	1	25	49
--------	25	--------	5	4	66
--------	25	--------	10	4	61
--------	------	25	1	1	73
--------	------	25	1	10	64
--------	------	25	1	25	49
--------	------	25	5	4	66
------ -	------	25	10	4	61

All of the said solutions were diluted with water (1 part of solution diluted to 100 parts) and the diluted solutions were possessed of bitter and metallic aftertastes. The addition of maltol in an amount to provide 10 p.p.m., based on the diluted solution, muted the aftertaste. Furthermore, the solutions were rendered more cleanly sweet to the taste, less bitter, milder and somewhat more bland. Substantially the same results were obtained at 5 p.p.m. of maltol, and at 30 and 100 p.p.m. of maltol. It was observed that the use of polyhydric alcohols produced a milder product than if maltol alone was used. Furthermore, if maltol is eliminated altogether, there is no muting effect of the aftertaste of the non-nutritive sweetening agents with propylene glycol, sorbitol, glycerol or mixtures thereof.

Example VII

A dietetic sweetener is formulated:

	Parts
Calcium cyclamate	1
Sodium saccharin	4
Propylene glycol	1
Water	94

This solution, containing 0.2 part of polyhydric alcohol per part of combined non-nutritive sweetening agent, is diluted with water (1 part solution per 99 parts of water) and maltol in an amount to provide 5 p.p.m. and 10 p.p.m. is added thereto. These solutions possess a desirable mild taste free of bitter and metallic aftertastes, which characterize the solution without maltol.

Similarly, a sweetener, suitable for table use, varied from the above formulation is prepared by substituting for 1 part of propylene glycol a combination of 30 parts of propylene glycol and 30 parts of sorbitol, while decreasing the amount of water to 35 parts and leaving out the cyclamate. This solution, which contains 15 parts of

combined polyhydric alcohols per part of non-nutritive sweetening agent, is diluted with 100 parts of water per part of solution and is rendered free of a metallic aftertaste by adding maltol in an amount to provide 10 p.p.m. based on the diluted solution. It is characterized by a mild and cleanly sweet taste.

What is claimed is:

1. In a method for sweetening comestibles with non-nutritive sweetening agents, the improvement which comprises masking the unpleasant aftertaste of said non-nutritive sweetening agents by incorporating with said sweetener maltol in an amount to provide from about 0.003 to about 160% by weight based on said sweetening agent.

2. A comestible containing in combination a non-nutritive sweetening agent, characterized by a bitter and metallic aftertaste and selected from the group consisting of cyclohexylsulfamic acid, saccharin, xylitol, arabitol, perillartine, stevioside, and their physiologically acceptable salts, and maltol in an amount to provide from about 0.003 to about 160% by weight of said sweetening agent.

3. In a method for sweetening oral cleaning agents with non-nutritive sweetening agents, the improvement which comprises masking the unpleasant aftertaste of said non-nutritive sweetening agents by incorporating with said sweetener maltol in an amount to provide from about 0.003 to about 160% by weight based on said sweetening agent.

4. An oral cleaning agent containing in combination a non-nutritive sweetening agent, characterized by a bitter and metallic aftertaste and selected from the group consisting of cyclohexylsulfamic acid, saccharin, xylitol, arabitol, perillartine, stevioside, and their physiologically acceptable salts, and maltol in an amount to provide from about 0.003 to about 160% by weight of said sweetening agent.

References Cited by the Examiner

UNITED STATES PATENTS

2,311,235	2/1943	Kuderman	99—141
2,971,848	2/1961	Polya	99—141
3,087,821	4/1963	Horowitz et al.	99—141
3,119,743	1/1964	Ericsson	167—93

OTHER REFERENCES

Hodge et al.: Cereal Chemistry, vol. 38, No. 3, pp. 221–228, June 1961.

Kingston: Manufacturing Chemist, vol. 33, No. 5, pp. 193–195, May 1962.

LEWIS GOTTS, *Primary Examiner.*

FRANK CACCIAPAGLIA, JR., *Examiner.*

R. HUFF, *Assistant Examiner.*

United States Patent Office 3,365,469 Patented Jan. 23, 1968

3,365,469

2-ARYLMETHYLPYROMECONIC ACIDS

Bryce E. Tate, Niantic, and Robert P. Allingham, Groton, Conn., assignors to Chas. Pfizer & Co., Inc., New York, N.Y., a corporation of Delaware

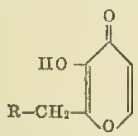
No Drawing. Continuation-in-part of application Ser. No. 310,141, Sept. 19, 1963. This application Nov. 1, 1966, Ser. No. 591,127

2 Claims. (Cl. 260—345.9)

The present invention is in part a continuation of copending application Serial No. 310,141, filed September 19, 1963, now abandoned.

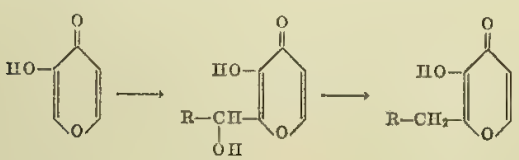
This invention relates to new and valuable organic compounds and to their use as flavor and aroma enhancers for edibles, aroma enhancers for perfumes and as antimicrobial agents. More particularly, it is concerned with the processes for the improvement of the flavor and aroma of foods and beverages, and the aroma of perfumes, which comprises the addition of a 2-arylmethylpyromeconic acid to such foods, beverages and perfumes. This invention also concerns the method for inhibiting the growth of microbes which comprises the addition of a 2-arylmethylpyromeconic acid to the locus of said microbes.

The new and valuable compounds of this invention are those of the formula:



where R is phenyl, naphthyl, substituted phenyl or substituted naphthyl and each of said substituents is alkyl having from 1 to 6 carbon atoms, hydroxy, chlorine, bromine, iodine or alkoxy having from 1 to 6 carbon atoms.

The 2-arylmethylpyromeconic acids of this invention are prepared by a modification of the process disclosed and claimed in U.S. Patent 3,130,204 issued to Bryce E. Tate and Robert L. Miller. The compounds are prepared by reacting pyromeconic acid with an aryl aldehyde and thereafter reducing the intermediate 2-(1-hydroxy-1-arylmethyl)pyromeconic acid, obtained. This process is carried out according to the following sequence:



where R is as aforesaid.

The conversion of pyromeconic acid to 2-(1-hydroxy-1-arylmethyl)pyromeconic acid is accomplished in excellent yield, by carrying out the reaction at a pH of above about 5, and preferably above about 8. Of course, as is obvious to those skilled in the art, with an aryl aldehyde it is desirable to use a water-miscible solvent to provide for more intimate mixing of the reagents. Dioxane is a useful solvent in this step. Bases such as sodium hydroxide, potassium hydroxide, lithium hydroxide and the like can be used for bringing the pH of the reaction mixture to

above at least 5. For optimum yields, it is preferred to limit the amount of aldehyde added, to one mole equivalent based on the pyromeconic acid. The use of an excess of aldehyde may decrease the purity of the product if an aqueous medium is employed.

The following represents a preferred embodiment of Step 1 in the process: Pyromeconic acid is added to about 4 times its weight of water and to the desired mixture is added sufficient 50% by weight aqueous base solution to bring the pH of the resulting mixture to about 10. To this solution is added one mole equivalent of the aldehyde dissolved in minimum volume of dioxane. The resulting mixture is stirred at 50° C. for about 18 hours, then is cooled and adjusted to pH 2 with strong acid. Cooling the reaction mixture to about 5° C. causes the desired product to precipitate, in crystalline form, from the reaction mixture, from which it is recovered by filtration.

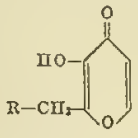
With respect to Step 2, the conversion of 2-(1-hydroxy-1-arlymethyl)pyromeconic acid to the corresponding 2-arylmethylpyromeconic acid, is carried out under acidic to substantially neutral conditions. If such a reaction is attempted in an alkaline medium, wherein the said hydroxy-substituted-pyromeconic acid species is predominately of the anion form, the yield of product is very low after treatment of the solution with a reducing agent. A number of reducing means may be employed in this step, for example, a zinc-hydrochloric acid combination or similar metal-acid combination or, alternatively, chemical reducing agents, or hydrogen and a catalyst may be used. With respect to the embodiment of metal-acid combinations as the reducing agent, it has been found that zinc, iron, aluminum, tin, magnesium, and the like, are effective to displace hydrogen from the acid. It is especially preferred to use zinc since this metal in addition to its economic advantage has a tendency to provide products with somewhat higher purity and lighter color. Mineral, or monocarboxylic saturated open-chain aliphatic acids having from one to ten carbon atoms and which are soluble in the reaction system, can be employed in combinations with metals of the aforesaid type. Among the aliphatic acids which are particularly effective are formic and acetic. It is especially preferred to use hydrochloric acid in this step since the compound formed has a tendency to be obtained in higher yield and higher purity.

Step 2 is accomplished by adding about one volume of 2-(1-hydroxyl-1-arylmethyl)pyromeconic acid to about 5 volumes of water and treating the suspension with enough strong acid, for example, sulfuric or hydrochloric, to bring the pH to below about 5. The slurry is then heated to about 50–55° C. and an amount of zinc dust is added equivalent to about 2 moles per mole of compound to be reduced. Although this is a 100% excess, with certain grades of zinc dust, less may be required. The reason for the variation in efficiency between certain grades of zinc dust is not clearly understood at the present time. In some cases 1.3 moles of zinc per mole of substituted pyromeconic acid has been found to be sufficient. The reaction mixture is then stirred vigorously and an aqueous solution of about 10 N hydrochloric acid containing at least a stoichiometrically-equivalent amount of acid based on the hydroxy intermediate, is slowly added over a period of about 1 hour. After all the acid has been added the reaction mixture is maintained at about 55–60° C. for from about 3 to about 5 hours. The mixture is then filtered while it is

hot, then is cooled and the crystalline product which forms is collected.

Since 2-arylmethylpyromeconic acids contain acidic hydrogen, in addition to the free acids, it is intended to include within this invention alkali addition salts of the compounds. These salts are formed in the usual manner, for example, by reacting the new compounds with a base, such as alkali metal hydroxides, alkaline earth metal hydroxides or an organic base. Especially useful salts are those of sodium, potassium, calcium and ammonia.

Broadly, this invention covers novel compounds having the formula:



where R is phenyl, naphthyl, substituted phenyl or substituted naphthyl and each of said substituents is alkyl having from 1 to 6 carbon atoms, hydroxy, chlorine, bromine, iodine or alkoxy having from 1 to 6 carbon atoms. Specifically contemplated is the compound where R is phenyl.

Also contemplated in this invention is a method of enhancing the aroma of edibles and perfumes and the flavor of edibles which comprises adding an effective concentration of one of the aforesaid compounds thereto and, more specifically, adding from about 1 to about 500 parts per million by weight of the compound thereto.

Further contemplated in this invention are edibles and perfume compositions containing as flavor and aroma enhancers, one of the aforesaid compounds and, more specifically, 2-benzylpyromeconic acid.

Also, contemplated in this invention is the method for inhibiting microbial growth which comprises adding an inhibiting amount of one of the aforesaid compounds to the locus of said microbes and, more specifically, adding from about 2 to about 10,000 parts per million by weight of said compound.

This invention also contemplates antimicrobial compositions comprising one of the aforesaid compounds and a carrier.

With respect to enhancing the aroma and flavor of edibles, particular mention is made of the especially desirable increase in appeal which is obtained when the 2-arylmethylpyromeconic acids are added in amounts to provide from about 1 to about 500 parts per million by weight. It is observed that below about 1 part per million there is a tendency for some people to have difficulty in discerning the beneficial effect of the addition and that above about 500 p.p.m. some begin to notice an aroma effect contributed by the acids themselves. It is obvious to those skilled in the art to which this subject matter pertains that for varying purposes varying amounts are required, which may be determined by experimentation. Thus, in some products test subjects have difficulty in discerning 5 p.p.m. and also in some products less desirable effects observed above about 100 p.p.m. With respect to enhancing the aroma of perfumes, generally the same levels of 2-arylmethylpyromeconic acid, as in food, can be employed. As will be understood by those skilled in the art, the precise amount of acid to be added will depend on the desired strength of the perfume odor itself. It is found that 2-benzylpyromeconic acid has a slightly-sweet, floral odor itself and contributes this odor to perfumes giving them a longer-lasting effect. In addition, it has been found that the addition of this compound to perfumes strengthens the aroma of the perfume by as much as 15%.

With respect to the term edibles, used herein and in the appended claims, it is contemplated to include compositions which are ordinarily eaten or drunk. For example, 2-benzylpyromeconic acid is particularly effective in enhancing the flavor and aroma of chocolate and vanilla products, candies, ice cream, cake mixes, cookies, pies, desserts, fruit juices, wines, liqueurs and flavor extracts. Furthermore, it can be used as flavor and aroma component in canned and frozen fruits and vegetables, meat and fish products, cereals, macaroni and noodle products, soups, sauces and seasonings, prepared dressings and breads. In addition, among the edibles which can be benefitted by the process of the instant invention are pharmaceutical oral dosage forms, animal feeds and pet foods. With respect to the term perfumes, as used herein and in the appended claims, it is meant to include concentrated essences, colognes, and industrial odorants which are commonly used in cosmetic and hygienic products, such as detergents and soaps, and in the perfuming of tobacco, paper, textiles, printing inks, food packages, paints, home deodorants and insecticides.

The 2-arylmethylpyromeconic acids of this invention, at very low levels, strengthen the flavor and aroma of a wide variety of products. They develop inherent flavors and create, especially in sweet foods, a "velvet mouth sensation." Because they so strongly augment many inherent flavors, as for instance, to achieve optimum taste; these reformulations are well within the capability of those skilled in the art. The compounds of this invention may be added to the food or perfume directly in the dry form or, alternatively, as solutions. Care should be taken to obtain even distribution through the use of pre-mixing if necessary, since such small quantities have such a powerful effect.

It has been found that the 2-arylmethylpyromeconic acids prepared as described hereinbefore have antimicrobial properties. This property is particularly valuable since it is a matter of common knowledge and experience that uncontrolled microbial growth is responsible for serious economic losses through food damage and in numerous instances of disease in man and in animals. In the past, it has been proposed to add many chemical agents to foods or to other substances to prevent the destruction thereof by the uncontrolled growth of microbes therein. Furthermore, infections in humans and animals have been controlled by the administration of certain substances in microbe-controlling concentrations at the site of infection in the host. In addition, microbe-controlling agents have been employed in medical diagnostic techniques and in industrial processes where it is necessary to control the growth of undesirable microbes. 2-benzylpyromeconic acid possesses a high order of activity as a microbe-controlling agent, and as a consequence, since small amounts can be used, it offers substantial economy in comparison with many previously employed chemical agents.

By the term microbe inhibiting concentration, used herein and in the appended claims, is contemplated levels of from about 10 to several thousand parts per million by weight. The effective ranges will depend on the microbe in question. In general, the low acute toxicity of these compounds allows large concentrations to be used where necessary.

The process for controlling microbial growth contemplates the addition of the compound either in the solid form or, alternatively, dissolved in solutions or in forms ordinarily used for pharmaceutical preparations. These preparations contain the compounds, if desired, in the form of a salt thereof, in admixture with a pharmaceutical organic or inorganic carrier suitable for local administration. For making the carriers there are used substances that do not react with the said 2-arylmethylpyromeconic acids, for example, water, gelatin, lactose, starches, magnesium stearate, talc, vegetable oils, benzyl alcohol, gums, polyalkylene glycols, white petrolatum or other known carriers or medicaments. The pharmaceutical preparations may be in the form of tablets, powder, salves, or creams or in liquid forms as solutions, suspensions, or emulsions. If desired, they may be sterilized and/or may contain auxiliary substances such as preserving, stabilizing, wetting or emulsifying agents.

If it is desired to use the new process in the preservation of materials such as, for example, foods, the 2-arylmethylpyromeconic acid may be incorporated into the foods by any common technique employed by those skilled in the art. For example, if it is desired to control microbial growth in baked goods such as bread, the compounds may be mixed with the dough, may be sprinkled on the surface of said bread, or may be incorporated into the bread wrapping to provide the desired microbial effect.

By the term pharmaceutically-acceptable alkali addition salts in the appended claims is meant to include the alkali metals, alkaline earth metals and ammonium salts. The more common alkali metals include sodium and potassium. The alkaline earth metals included are those of atomic number up to and including 20, i.e., magnesium, calcium, and additionally, aluminum, zinc, iron and manganese, among others.

EXAMPLE I

2-benzylpyromeconic acid.—In an 8-liter stainless steel vessel fitted with a stirrer and an air sparger is placed a suspension of 350 grams of kojic acid in 3500 ml. of water. The pH is adjusted to 11.1 by addition of 256 ml. of 50% aqueous sodium hydroxide and then 142 g. (7.1 g. as metal) of a 5% palladium on charcoal catalyst is added. Air is passed into the suspension at a rate of about 2100 ml. per minute. The reaction, which is slightly exothermic, is maintained at a temperature of about 20–22° C. by occasional application of external cooling. After 11 hours the reaction mixture is filtered to remove the catalyst and is treated with 600 ml. of concentrated hydrochloric acid. The crystals of comenic acid which precipitate from the pH 0.5 mixture are removed by filtration, washed with a small amount of cold water and are air-dried. There is obtained 328 g. of product. This is 85.3% of the theoretical yield. Titration data indicate the product to be 99.2% pure; therefore, there is obtained an 84.6% yield of comenic acid as corrected for purity.

In a 150-ml. Pyrex flask fitted with a mechanical stirrer and a thermometer and connected through a distillation head to a receiver are placed 10.0 g. of comenic acid, prepared as described, and 30 ml. of diphenyl ether. The reaction mixture is stirred and heated by application of a heating mantle. After about 20 minutes, the temperature reaches 225° C. and gas is observed to pass into the receiver. When the temperature reaches 245–250° C., a vigorous evolution of carbon dioxide is observed. After an additional 40 minutes at 245–250° C., the pyromeconic acid is distilled therefrom until no more passes over at an internal temperature of 255° C. and a vapor temperature of 230° C. Thirty ml. of additional diphenyl ether is added to the reaction flask and a second fraction is obtained after distillation at 255° C. internal temperature for an additional 1 hour and 10 min. The product is suspended in about 5 volumes of hexane, then is removed by filtration, and is recrystallized in 4 volumes of toluene. There is obtained 5.71 g. of pyromeconic acid, M.P. 113–115.5. Concentration of the toluene mother-liquors to about 1/20 volume affords an additional 0.7 g. of somewhat less pure pyromeconic acid. The combined weight of pyromeconic acid obtained represents an 80% conversion.

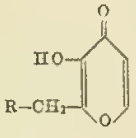
A solution of benzaldehyde, 53 g., 0.5 mole, in 175 cc. of dioxane is added to a stirred mixture of 56 g., 0.5 mole pyromeconic acid in 175 cc. of water, and sufficient 50% sodium hydroxide to give a final pH of 10.5 The temperature is maintained at 60° C. during the addition and for an additional 16 hours. The mixture is acidified (pH 2.5) with HCl and is extracted with chloroform and with ether. Evaporation of the solvents and recrystallization from ethyl acetate affords 45.5 g., 42% yield of 2-(1-hydroxy-1-phenylmethyl)pyromeconic acid, M.P. 142–143° C.

Analysis.—Calc'd for $C_{12}H_{10}O_4$: C, 66.05; H, 4.62. Found: C, 66.06; H, 4.81.

Concentrated HCl, 35 cc., is added dropwise over 25 minutes to a stirred mixture of 0.1 mole, 21.8 g., 2-(1-hydroxy-1-phenylmethyl)pyromeconic acid, 13.1 g., 0.2 mole zinc and 125 cc. of 25% aqueous ethanol. The temperature is maintained at 60–65° C. during addition and for an additional hour of stirring. After filtration and extraction of filtrates and filter cakes and recrystallization of crude fractions from ethyl acetate there is isolated 9.5 g., 47.5% yield, of product, M.P. 113–115° C. One additional recrystallization from ethyl acetate affords analytically pure 2-benzylpyromeconic acid.

Analysis.—Calc'd for $C_{12}H_{10}O_3$: C, 71.28; H, 4.99. Found: C, 71.16; H, 5.18.

The following compounds are prepared by reacting pyromeconic acid with the appropriate aldehyde according to this same procedure.



Aldehyde	R
p-Tolualdehyde	P-$CH_3C_6H_4$.
2-naphthaldehyde	2-$C_{10}H_7$.
1-naphthaldehyde	1-$C_{10}H_7$.
2,4-dimethyl-1-naphthaldehyde	$C_{12}H_{11}$.
5-methyl-1-naphthaldehyde	$C_{11}H_9$.
4-methyl-1-naphthaldehyde	$C_{11}H_9$.
6-methyl-2-naphthaldehyde	$C_{11}H_9$.
4-tolualdehyde	C_7H_7.
3-tolualdehyde	C_7H_7.
4-methoxybenzaldehyde	4-CH_3O—C_6H_4.
3-methoxybenzaldehyde	3-CH_3O—C_6H_4.
4-butoxybenzaldehyde	4-C_4H_7O—C_6H_4.
2-butoxybenzaldehyde	2-C_4H_7O—C_6H_4.
4-methoxy-1-naphthaldehyde	4-CH_3O—1-$C_{10}H_8$.
6-methoxy-1-naphthaldehyde	6-CH_3O—1-$C_{10}H_8$.
2-chlorobenzaldehyde	2-Cl—C_6H_4.
2-bromobenzaldehyde	2-Br—C_6H_4.
2-iodobenzaldehyde	2-I—C_6H_4.
3-chlorobenzaldehyde	3-Cl—C_6H_4.
3-bromobenzaldehyde	3-Br—C_6H_4.
3-iodobenzaldehyde	3-I—C_6H_4.
4-chlorobenzaldehyde	4-Cl—C_6H_4.
4-iodobenzaldehyde	4-I—C_6H_4.
2-chloro-1-naphthaldehyde	2-Cl—1-$C_{10}H_8$.
4-chloro-1-naphthaldehyde	4-Cl—1-$C_{10}H_8$.
6-chloro-1-naphthaldehyde	6-Cl—1-$C_{10}H_8$.
2-bromo-1-naphthaldehyde	2-Br—1-$C_{10}H_8$.
6-chloro-2-naphthaldehyde	6-Cl—2-$C_{10}H_8$.
4-chloro-2-naphthaldehyde	4-Cl—2-$C_{10}H_8$.
4-iodo-2-naphthaldehyde	4-I—2-$C_{10}H_8$.
4-hydroxy-1-naphthaldehyde	4-HO—1-$C_{10}H_8$.
5-hydroxy-1-naphthaldehyde	5-HO—1-$C_{10}H_8$.
6-hydroxy-1-naphthaldehyde	6-HO—1-$C_{10}H_8$.
2-hydroxybenzaldehyde	2-HO—C_6H_4.
3-hydroxybenzaldehyde	3-HO—C_6H_4.
4-hydroxybenzaldehyde	4-HO—C_6H_4.

EXAMPLE II

2-benzylpyromeconic acid was tested against several micro-organisms in Witkin synthetic medium and found to have a minimum inhibitory concentration (mcg./ml.) of 12.5 against *P. vulgaris* and 1.56 against *E. coli*. In a B-H infusion medium, the compound had an M.I.C. of 6.25 mcg./ml. against *Strep. pyrogenes* and 3.12 mcg./ml. against *Past. multocida*.

In an agar medium 2-benzylpyromeconic acid was effective against the micro-organisms of Table I.

Table I

Micro-organism	Percent Inhibition 10 mcg./ml.	100 mcg./ml.
1. *Phytophthora citrophthora*	0	100
2. *Sclerotinia fructicola*	0	100
3. *Botrytis cinerea*	0	100
4. *Geotrichum candidum*	0	25
5. *Alternaria citri*	0	50
6. *Diplodia natalensis*	31	43
7. *Penicillium digitatum*	0	20
8. *Aspergillus niger*	0	0
9. *Fusarium oxysporum*	0	50
10. *Phomopsis citri*	0	100
11. *Thielaviopsis paradoxa*	11	73
12. *Glomerella cingulata*	22	100
13. *Rhizopus stolonifera*	0	38

When the 2-arylmethylpyromeconic acids of Example I are similary tested, microbial growth is found to be inhibited.

EXAMPLE III

2-benzylpyromeconic acid alone is added to a perfume base solvent at 10 p.p.m. When the mixture is sprayed into an area it provides a pleasant floral aroma.

EXAMPLE IV

2-benzylpyromeconic acid is dissolved in a floral base cologne to provide 1, 50, 100, 250 and 500 p.p.m., respectively. The odors of the resulting perfume compositions are determined and compared with that of the untreated perfume as a control. The aromas of the 2-benzylpyromeconic acid-containing perfumes are significantly enhanced.

EXAMPLE V

When the products of Example I are added to vanilla ice cream at levels between 1 and 500 p.p.m., the vanilla flavor and aroma is found to be pleasingly enhanced.

EXAMPLE VI

When the products of Example I are included in a jasmine perfume base (Table I) the aroma of the perfume base is enhanced and strenghthened.

Table II

Perfume base:	Parts
Benzyl acetate	40
Linalool	10
α-Amylcinnamic aldehyde	10
2-arylmethylpyromeconic acid	4
Cinnamic alcohol	5
Phenylethyl alcohol	5

EXAMPLE VII

The sodium salt of 2-benzylpromeconic acid is prepared by dissolving one mole of the compound in a solution of sodium hydroxide (41 grams, 1.0 mole) in 100 ml. of water. To the solution is added 1500 ml. of acetone. The resulting precipitate of the sodium salt of 2-benzylpyromeconic acid is collected and dried.

In a similar manner, the sodium salts of the compounds of Example I, are prepared. The potassium salts are prepared by replacing sodium hydroxide with potassium hydroxide in the above-described procedure and replacing acetone with isopropyl alcohol.

EXAMPLE VIII

The ferric salt of 2-benzylpyromeconic acid is prepared by dissolving 3.66 moles of ferric chloric ($FeCl_3 \cdot 6H_2O$) in 8250 ml. of water and adding 11.0 moles of 2-benzylpyromeconic acid thereto. The mixture is heated to 65° C. and the pH is adjusted to 5.5 with 50% aqueous sodium hydroxide. The mixture is then stirred at ambient temperature for 1.5 hours with the pH being readjusted to 5.5. The mixture is cooled to 34° C. and stirred at ambient temperature for 2.5 hours, cooled and filtered. The solid precipitate of the ferric salt of 2-benzylpyromeconic acid is obtained in good yield.

In the same manner, are obtained the ferric salts of the compounds of Example I.

EXAMPLE IX

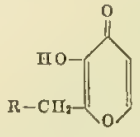
The magnesium salt of 2-benzylpyromeconic acid is obtained by adding 0.01 mole of magnesium hydroxide, $Mg(OH_2)$, to a solution of 0.02 mole of the compound in 100 ml. of water. The mixture is heated to 80° C. with stirring and is filtered hot to remove insoluble impurities. The filtrate is freeze-dried to give the magnesium salt in good yield.

The aluminum salt of 2-benzylpromeconic acid is obtained by replacing magnesium hydroxide with aluminum isopropoxide in the procedure described above. The calcium salt is obtained by replacing magnesium hydroxide with calcium hydroxide.

In a similar manner the magnesium, aluminum, ammonium and calcium salts of the compounds of Example I are prepared.

What is claimed is:

1. A compound selected from the group consisting of those having the formula:



where R is phenyl, naphthyl, substituted phenyl or substituted naphthyl and each of said substituents is alkyl having from 1 to 6 carbon atoms, hydroxy, chlorine, bromine, iodine or alkoxy having from 1 to 6 carbon atoms; and the alkali addition salts thereof.

2. The compound of claim 1 wherein R is phenyl.

References Cited

UNITED STATES PATENTS

3,130,204 4/1964 Tate et al. ---------- 260—345.9

OTHER REFERENCES

Index Chemicus, vol. 6, No. 5, issue 53, Sept. 15, 1962, page 16 (21189).

NORMA S. MILESTONE, *Primary Examiner.*

United States Patent Office 3,376,317 Patented Apr. 2, 1968

3,376,317

2-ETHYLPYROMECONIC ACID AS AROMA AND FLAVOR COMPONENT

Charles R. Stephens, Jr., East Lyme, and Robert P. Allingham, Groton, Conn., assignors to Chas. Pfizer & Co., Inc., New York, N.Y., a corporation of Delaware

No Drawing. Continuation-in-part of application Ser. No. 310,919, Sept. 23, 1963. This application Apr. 14, 1967, Ser. No. 630,818

1 Claim. (Cl. 260—345.9)

ABSTRACT OF THE DISCLOSURE

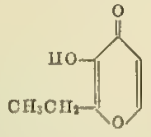
2-ethylpyromeconic acid and its use in improving the flavor and aroma of edibles and the aroma of perfumes.

This application is a continuation-in-part of copending application Ser. No. 310,919 filed Sept. 23, 1963 and now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to providing improved flavor and aroma in edibles and improved aroma in perfumes. More particularly, it is concerned with processes for the improvement of flavor and aroma of foods and beverages and the aroma of perfumes which comprise the addition of 2-ethylpyromeconic acid thereto. In addition, it contemplates compositions of edibles and of perfumes which contain the said 2-ethylpyromeconic acid.

2-ethylpyromeconic acid is a gamma-pyrone of the formula:



It is an acidic substance which forms salts with bases, which salts can be used interchangeably with the free acid in the instant invention.

It is a matter of common knowledge and experience that the addition of maltol, also known as 2-methylpyromeconic acid, a valuable gamma-pyrone, to many foods improves the flavor and aroma thereof to such an extent that wide consumer acceptance of the practice has been obtained. This appreciation of improved flavor is reflected in increased sales volume of foods so treated. Furthermore, numerous taste panel tests demonstrate that many foods containing maltol are preferred over those from which it is omitted. This acceptance has been found, for example, in edibles such as beverages, confections, baked goods, and ice cream. Furthermore, maltol has been added to perfumes, which have their appeal heightened because of maltol's effect of enhancing the desirable aroma thereof.

Maltol is extremely beneficial in the replacement of certain other classical flavor and aroma enhancers in that it is generally much more powerful and, for this reason, can be used in lower amounts. An advantage in this practice is immediately obvious in that such a high strength enhancer may be used at lower levels and, as a result, the natural taste of maltol itself does not overpower the desired edible flavor and aroma or perfume aroma. For example, it is known that maltol can replace four times its weight of coumarin. Although coumarin has been used very widely in the past, it has such a powerful aroma of its own, resembling that of vanilla beans, that great care must be used to prevent so much being added as to overpower the compositions, maltol, on the other hand, is used in smaller amounts than coumarin, thus providing

a margin of safety. Because of this and its lack of toxicity, maltol has replaced coumarin in many foods.

It has now been found that the compound 2-ethylpyromeconic acid, surprisingly, is very much more effective than maltol as a flavor and aroma enhancer. In fact, 2-ethylpyromeconic acid has an aroma and flavor-enhancing power of about 6 times that of maltol. Thus, on a relative basis, one part by weight of 2-ethylpyromeconic acid is equivalent to about 24 parts of the aforesaid coumarin in its flavor and aroma enhancing effect.

The advantage in using 2-ethylpyromeconic acid becomes immediately obvious after considering that the relative costs of the said 2-ethylpyromeconic acid and of maltol are of approximately the same order of magnitude. Thus, the consumer is able to use only about one-sixth as much of the 2-ethylpyromeconic acid to achieve the same level of flavor and odor enhancement and realizes very significant savings in manufacturing cost. Furthermore, because of its effectiveness at such low concentrations, effects not possible to achieve with maltol are observed with 2-ethylpyromeconic acid.

It is, therefore, an object of the instant invention to provide means of enhancing the flavor and aroma of edibles and the aroma of perfume, said means being achieved with a substantial decrease in cost as compared with commonly employed means.

It is a further object of the instant invention to provide edible compositions with enhanced flavor and aroma, said compositions being obtained at substantially less cost than those of the prior art.

It is a further object of the instant invention to provide perfume compositions, said compositions having enhanced aroma and being obtained at substantial cost savings over perfume compositions of the prior art.

It is a still further object of the instant invention to provide means for enhancing the flavor and aroma of edibles and the aroma of perfumes, said means not contributing any appreciable, undesirable flavor and aroma of its own to the edibles and perfumes.

These and other objects of the instant invention are readily achieved through use of the process of this invention which, in essence, comprises enhancing the aroma of edibles and perfumes and the flavor of edibles by adding 2-ethylpyromeconic acid thereto.

With respect to enhancing the aroma and flavor of edibles, particular mention is made of the especially desirable increase in appeal which is obtained when 2-ethylpyromeconic acid is added in an amount to provide from about 1 to about 100 parts per million by weight. It is observed that below about 1 part per million there is a tendency for some of the test subjects to have difficulty in discerning the beneficial effect of the addition and that above about 100 p.p.m. some of the subjects begin to notice an aroma effect contributed by the 2-ethylpyromeconic acid itself. It is obvious to those skilled in the art to which this subject matter pertains that for varying purposes varying amounts are required, which may be determined by experimentation. Thus, in some products the test subjects have difficulty in discerning 5 p.p.m. and also in some products less desirable effects are observed above about 100 p.p.m. With respect to enhancing the aroma of perfumes, generally, the same levels of 2-ethylpyromeconic acid, as in food, can be employed. As will be understood by those skilled in the art, the precise amount of 2-ethylpyromeconic acid to be added will depend on the desired strength of the perfume odor itself. It is found especially convenient to substitute about ⅙ part by weight of 2-ethylpyromeconic acid for each 1 part by weight of maltol in those formulations where maltol is a component. Since, at the present time, maltol costs about $12 per pound; substantial savings may be obtained

through the substitution of 2-ethylpyromeconic acid for maltol.

2-ethylpyromeconic acid is a novel gamma-pyrone which is readily prepared by a process which is the subject of a copending application, Ser. No. 310,141, filed Sept. 19, 1963 and now abandoned, by B. E. Tate and R. P. Allingham and assigned to the assignee of the instant invention. As is disclosed in said copending application, 2-ethylpyromeconic acid is prepared readily and economically by a combination of a fermentation technique and organic synthesis. The starting material for the said synthesis in kojic acid and the process generally comprises the steps of oxidizing kojic acid to comenic acid, of decarboxylating said comenic acid to pyromeconic acid, of treating said pyromeconic acid with acetaldehyde to form 2-(1-hydroxy)ethylpyromeconic acid, and reducing this to 2-ethylpyromeconic acid.

With respect to the term "edibles," used herein and in the appended claim, it is contemplated to include compositions which are ordinarily eaten or drunk. For example, 2-ethylpyromeconic acid is a powerful flavor and aroma enhancer for chocolate and vanilla products, candies, ice cream, cake mixes, cookies, pies, desserts, fruit juices, wines, liqueurs and flavor extracts. Furthermore, it can be used as a flavor and aroma component in canned and frozen fruits and vegetables, meat and fish products, cereals, macaroni and noodle products, soups, sauces and seasonings, prepared dressings, and breads. In addition, among the edibles which can be benefitted by the process of the instant invention are pharmaceutical oral dosage forms, animal feeds and pet foods. With respect to the term "perfumes," as used herein and in the appended claims it is meant to contemplate concentrated essences, colognes, and industrial odorants which are commonly used in cosmetic and hygienic products, such as detergents and soaps, and in the perfuming of tobacco, paper, textiles, printing inks, food packages, paints, home deodorants and insecticides.

As has been mentioned hereinbefore, 2-ethylpyromeconic acid at a very low level strengthens the flavor and aroma of a wide variety of products. It develops inherent flavors and creates, especially in sweet foods, a "velvet mouth sensation." Because it so strongly augments many inherent flavors, as for instance, that of chocolate, product reformulation may be required in some instances to achieve optimum taste; these reformulations are well within the capability of those skilled in the art. 2-ethylpyromeconic acid may be added to the food or perfume directly in the dry form or, alternatively, as a solution. Care should be taken to obtain even distribution through the use of pre-mixing if necessary, since such small quantities have such a powerful effect.

The following specific examples illustrate the practice of the invention, but are not to be construed as limiting the invention to the foods specifically disclosed.

EXAMPLE I

Aqueous solutions of 2-ethylpyromeconic acid and of maltol are serially diluted and matched as to odor intensity. It is found that 2-methylpyromeconic acid has an aroma 6 times as strong as that of maltol. Furthermore, this effect is noticed at a considerably lower concentration than that previously recorded for maltol.

EXAMPLE II

2-ethylpyromeconic acid is added to chocolate bars by melting the bars and incorporating into one sample 20 p.p.m. and into another 40 p.p.m. The bars are recast and tasted and compared with chocolate to which no 2-ethylpyromeconic acid has been added. It is found that the 2-ethylpyromeconic acid increases the richness of the chocolate flavor and creates a blended taste by evening off harsh chocolate notes and lifting the aroma, as compared with the control.

EXAMPLE III

2-ethylpyromeconic acid is added to a commercial yellow cake mix at 4, 13, 25, 41, 80 and 100 p.p.m., based on dry weight. The cakes are prepared according to label directions. There is also prepared a control cake, which does not contain 2-ethylpyromeconic acid. 2-ethylpyromeconic acid added at 13 p.p.m. appears to give the best enhancement of aroma and flavor. For all the cakes, those containing 2-ethylpyromeconic acid are superior to control.

Commercial angel food cake mix is given an increased taste appeal by the addition of 40 p.p.m. of 2-ethylpyromeconic acid. Since the flavor of presently available angel food cake mixes is rather bland, the addition of 2-ethylpyromeconic acid provides a means for improving this product.

A pineapple cake mix is similarly tested with 40 p.p.m. of 2-ethylpyromeconic acid and is more attractive in flavor and aroma than the control.

A coconut macaroon mix containing 40 p.p.m. of 2-ethylpyromeconic acid is baked yielding a richer-tasting cookie with a stronger coconut flavor and smoother mouth feel than the control. During mixing, the coconut aroma is more evident in the cookie mixture containing the 2-ethylpyromeconic acid.

EXAMPLE IV

A chocolate fudge is prepared containing 2-ethylpyromeconic acid and is compared with a control; the basic creme fondant is prepared containing 40 p.p.m. of 2-ethylpyromeconic acid. The 2-ethylpyromeconic acid strongly reinforces the chocolate flavor and the product is judged to have a more pleasant fragrance.

Creme candies are prepared containing 20 p.p.m. of 2-ethylpyromeconic acid; they are found to have significantly better flavors than those which do not contain the said acid.

EXAMPLE V

Pineapple juice flavor is pleasantly enhanced when 2-ethylpyromeconic acid is added at 4 p.p.m., and compared with a control.

Ten p.p.m. of 2-ethylpyromeconic acid added to grape juice greatly amplifies the natural sweet grape aroma.

Five p.p.m. of 2-ethylpyromeconic acid in sherry wine provides an improved flavor; 10 p.p.m. of 2-ethylpyromeconic acid creates a pleasant change in bouquet.

The flavor of an orange-type liqueur is sweetened by the addition of 10 p.p.m. of 2-ethylpyromeconic acid to said liqueur.

The fruit flavor of a low calorie orange drink is enhanced by adding 1 p.p.m. of 2-ethylpyromeconic acid thereto.

EXAMPLE VI

2-ethylpyromeconic acid is dissolved in a floral base cologne to provide 4, 8, 10, 25, 50, 75, 100 and 250 p.p.m., respectively. The odors of the resulting perfume compositions are determined and compared with that of the untreated perfume as a control. The aromas of the 2-ethylpyromeconic acid-containing perfumes are significantly enhanced.

EXAMPLE VII

2-ethylpyromeconic acid alone is added to a perfume base solvent at 10 p.p.m. When this is sprayed into an area it provides a pleasant cotton-candy like aroma.

EXAMPLE VIII

Ethyl maltol, propyl maltol and maltol were evaluated as to their taste and odor characteristics by a professional flavor chemist having nine years experience in food and perfume chemistry.

Protocol.—Three solutions were prepared containing respectively 100 p.p.m. of maltol (2-methylpyromeconic acid), ethyl maltol (2-ethylpyromeconic acid), and pro-

pyl maltol (2-propylpyromeconic acid) in 25% ethanol-water. Each solution was further diluted with water to levels of 500, 200, 100 and 10 p.p.m. Each of the twelve samples was evaluated as to odor and odor intensity.

Conclusion.—The flavor chemist concluded that (1) the sample containing 500 p.p.m. maltol had about the same level of odor intensity as the sample with 100 p.p.m. ethyl maltol. (2) The sample containing 10 p.p.m. ethyl maltol had an odor intensity stronger than the sample containing 100 p.p.m. propyl maltol but less intense than the sample containing 100 p.p.m. maltol. (3) Ethyl maltol-containing samples had an odor character similar to maltol but more intense, sweeter and more desirable than the odor of maltol.

EXAMPLE IX

The flavor chemist of Example VIII evaluated ethyl maltol, propyl maltol and maltol as to their flavor and odor intensities when contained in a strawberry beverage.

Protocol.—A strawberry beverage was prepared according to the following formulation:

Strawberry beverage:	Percent
Sugar	8.40
Citric acid	0.14
Water	91.21
Strawberry flavor	0.25
	100.00

Strawberry flavor:	Grams
Vanillin	0.10
Ethyl butyrate	0.35
EMPG [1]	1.00
Strawberry coeur	0.50
Ethyl alcohol	98.05
	100.00

[1] Ethyl methyl phenyl glycidate.

To four 200-gram samples of the strawberry beverage were added, respectively, 100 p.p.m. maltol (A), 20 p.p.m. ethyl maltol (B), 100 p.p.m. propyl maltol (C), and 500 p.p.m. propyl maltol (D). A fifth 200-gram sample was used as a control beverage (E) i.e., it contained no maltol of maltol analog. The samples were tested by the flavor chemist.

Results.—The flavor chemist indicated the following samples were of the odor and flavor intensities indicated:

Sample A stronger than C
Sample A stronger than E
Sample B equal to A
Sample B stronger than C
Sample B stronger than E
Sample C equal to E
Sample D has a predominant off taste

Conclusion.—The flavor chemist concluded from the results of his tests that

(1) The two beverage samples containing 20 p.p.m. ethyl maltol and 100 p.p.m. maltol, respectively, proved to have an outstanding strawberry flavor, superior in strength to the control beverage and to the beverage containing 100 p.p.m. propyl maltol.

(2) The strawberry beverage containing 20 p.p.m. of ethyl maltol had a strawberry flavor equally as intense as the strawberry beverage containing 100 p.p.m. maltol.

(3) A beverage containing 100 p.p.m. propyl maltol proved to have a comparable taste to the control beverage and thus showed no advantageous effect.

(4) A beverage containing 500 p.p.m. propyl maltol was found to have a predominant off taste and thus to have an undesirable effect.

EXAMPLE X

A strawberry beverage was prepared according to the formulation of Example IX. The control beverage was divided into three parts. To one part was added ethyl maltol in an amount to give a 20 p.p.m. concentration in the beverage. To the second part was added maltol in an amount to give 20 p.p.m. concentration in the beverage. The third part was used as a control and contained no maltol or ethyl maltol.

Each sample was compared by the flavor chemist of Example VIII. He concluded that sample containing 20 p.p.m. ethyl maltol had a stronger, more intense and more natural taste than did the sample containing 20 p.p.m. malto. The control sample had a taste, less intense than the samples containing either 20 p.p.m. of ethyl maltol or 20 p.p.m. of maltol.

EXAMPLE XI

Two taste panels of specially selected members each of whom had previously shown a particular sensitivity to variations in the taste and aroma of foods, were brought together for the purpose of comparing the effect of maltol, ethyl maltol and propyl maltol in foods.

Part A.—A triangle panel evaluation of maltol and with propyl maltol was conducted using five judges who had each previously participated in similar test programs and who were familiar with the psychophysical procedure of sensory panel evaluations.

Protocol.—Each panel member was given three samples, designated No. 1, No. 2 and No. 3, and asked to taste each and determine which was the odd sample and which two were alike, and to state his preference of the three samples.

Test samples.—The strawberry beverage control prepared according to the formulation of Example IX was used. To samples No. 1 and No. 3 of the control beverage were added sufficient propyl maltol to give 100 p.p.m. of propyl maltol. To sample No. 2 was added maltol in an amount to give 100 p.p.m.

RESULTS

Taster	A	B	C	D	E
First Preference	1,3	2	2	2	1
Second Preference	2	1,3	1,3	1,3	2,3
Like Samples	1,3	1,3	1,3	1,3	2,3
Odd Sample	2	2	2	2	1

Descriptive phrases used by the tasters for the samples:

Propyl maltol sample:
"not as sweet"
"slightly bitter"
"more flat"
"not fruity"

Maltol sample:
"more sweet"
"more fruity"
"more pronounced strawberry flavor"

Conclusion.—Four out of five tasters selected the odd sample correctly. Three of these four tasters preferred the taste of the sample containing maltol to the sample containing an equal amount of propyl maltol.

Part B.—A skilled and well-qualified taste panel of seven members was brought together. Each member was experienced in testing the flavor and aromas of foods, food additives and flavor and aroma enhancers. The panel was asked to select the more flavorful of two blind samples of a strawberry gelatin dessert. An eighth panel member was asked to participate during the latter part of the testing.

Protocol.—Flavor testing was conducted over a period of five days in a specially constructed flavor panel room provided with red lights to prevent the panelists from discerning the color of the samples. Each panelist's booth was individually partitioned. The testing room was air-conditioned and free from noise and distractions. A period of about three hours was allowed between the time an individual panelist made one judgment regarding a pair of samples and his next judgement on another pair of samples. Drinking water and a bland cracker were available for each panelist, in the event he believed he could

still taste the first sample before tasting the second sample of a pair. Each pair of samples consisted of a sample containing maltol and a sample containing ethyl maltol. The samples were randomized in the sense that during any one testing period, half the panelists were given the maltol sample first and half were given the ethyl maltol sample first. Panelists were asked to mark their preference on a ballot.

Test samples

Control.—To 85 grams of a strawberry-flavored gelatin dessert powder base was added 30 mg. of maltol. The powder mixture was stirred and blended with 1 pint hot water and allowed to cool and gel. The strawberry-flavored gelatin dessert powder base was a commercial formulation containing only sugar, strawberry flavor and gelatin.

Samples.—Samples of strawberry-flavored gelatin dessert containing ethyl maltol were prepared by adding varying amounts of ethyl maltol to 85 gram lots of the strawberry-flavored gelatin dessert powder base. One pint of hot water was added to each sample and the samples were allowed to cool and gel.

Formulation:

Strawberry-flavored gelatin dessert powder base	grams	85
Water	pint	1
Additive, as indicated below.		

Sample (No.)	Additive	Amount (mg.)	Ethyl Maltol Level [1]
1	Maltol	30	0
2	Ethyl maltol	15	½
3	do	10	⅓
4	do	7.5	¼
5	do	6.0	⅕
6	do	5.0	⅙
7	do	4.3	1/7
8	do	3.8	⅛
9	do	3.3	1/9
10	do	3.0	1/10

[1] Level of ethyl maltol in sample compared to level of maltol in sample 1.

Summary of results

Level of ethyl maltol as compared to maltol level:	Number of panelists preferring ethyl maltol sample
½	7–7
⅓	6–7
¼	7–7
⅕	6–7
⅙	4–7
1/7	4–7
⅛	0–8
1/9	1–8
1/10	1–8

Conclusion.—Maltol, when added to a strawberry-flavored gelatin dessert, gives a less flavorful product than does a gelatin dessert to which is added ethyl maltol at levels of from ½ down to about ⅕ those of maltol in the maltol-containing dessert.

What is claimed is:

1. 2-ethylpyromeconic acid.

References Cited

UNITED STATES PATENTS

3,130,204 4/1964 Tate et al. ..... 260—345.9

OTHER REFERENCES

Index Chemicus, volume 6, No. 5, Issue 53, p. 16 (21189), Sept. 15, 1962.

Kingston, Manufacturing Chemist, volume 33, No. 5, May 1962, pp. 193–195.

NORMA S. MILESTONE, *Primary Examiner.*

United States Patent Office 3,409,441
Patented Nov. 5, 1968

3,409,441

PROCESS OF SWEETENING FOODS WITH MALTOL AND SUGAR

Edward F. Bouchard, Northport, Carl P. Hetzel, Bellerose, and Robert D. Olsen, Brooklyn, N.Y., assignors to Chas. Pfizer & Co., Inc., New York, N.Y., a corporation of Delaware

No Drawing. Continuation-in-part of application Ser. No. 310,155, Sept. 19, 1963. This application Oct. 11, 1966, Ser. No. 585,758

3 Claims. (Cl. 99—28)

ABSTRACT OF THE DISCLOSURE

The sugar content of a food is decreased while maintaining the same total sweetness by substituting from 5 to 75 p.p.m. by weight of maltol for up to 15% of the sugar. At these concentrations the maltol potentiates the sweetness without itself contributing flavor.

The present application is in part a continuation of copending application Ser. No. 310,155, now abandoned, filed Sept. 19, 1963.

This invention relates to sugar-containing compositions with enhanced sweetness and to processes for their use in foods. More particularly, it is concerned with compositions containing sugar and maltol and with processes for the preparation of sweetened foods more economically comprising replacing part of the sugar ordinarily used with a very much smaller amount of maltol.

Maltol, also known as 2-methyl-3-hydroxy-gamma-pyrone, has been enjoying increased use in enhancing the flavor and aroma of foods. However, maltol has not been known to increase the apparent sweetness of sugar. It has now been discovered that maltol, surprisingly, has a powerful lifting effect on the sweetness of sugar and, as a result, it is possible to replace part of the sugar in sweetening compositions with maltol. Maltol, has been found to actually potentiate the sweetness of sugar without adding a taste of its own and without merely replacing one taste with another. Indeed, maltol, by itself, does not possess a sweet taste. Furthermore, this enhancement of sweetness is so pronounced that as much as 15 parts by weight of sugar in a composition containing 100 parts of sugar can be replaced with only from about 5 parts per million to about 75 parts per million of maltol.

Since the price of sugar represents a significant portion of the total manufacturing cost of many foods, such as, for example, baked goods, candies, carbonated beverages and fruit drinks, the reduced sugar levels in compositions and processes of the instant invention allow significant economic savings to be obtained. For example, consideration might be given to the typical savings obtained on using 10% less sugar in a lemonade formulation: Ordinarily, 800 pounds of sucrose is used to make 1000 gallons of lemonade. At 11 cents a pound, the current market price for sucrose, which tends to fluctuate from time to time, this represents a value of $88 for the sugar. Decreasing the amount of sucrose by 10%, to 720 pounds, results in a new cost of sugar in 1000 gallons of lemonade of $79.20, but the lemonade is less sweet, flatter and more acid to the taste. It is found that, by the process of the instant invention, the addition of 58 grams of maltol to 1000 gallons of lemonade containing the decreased amount of sugar causes such an enhancement in sweetness that the lower sugar-containing lemonade is identical with the original, 10% sugar-containing formulation. At the current maltol market price of $12 a pound, the amount of maltol added represents $1.50 per 1000 gallons of lemonade. Thus, $8.80 saved on lowering the sugar content has been achieved at a net maltol cost of $1.50 and a total

net savings of $7.50 per 1000 gallons of lemonade is realized. Other important cost savings achieved by the application of the processes of the instant invention to other sugar-containing foods readily are recognizable.

It is accordingly an object of the instant invention to provide sweetened foods at less cost.

It is a further object of the instant invention to provide means to reduce the cost of sweetened foods while maintaining sweetness at the same level.

These and other objects of the instant invention will be readily achieved through practice of the process which comprises, in essence: A process for decreasing the amount of sugar in a food while maintaining the same total sweetness which comprises replacing 100 parts of said sugar with a composition comprising up to 90 parts of sugar and maltol in an amount to provide from about 5 to about 75 parts per million (p.p.m.) by weight based on said food.

Also contemplated by the instant invention is a process for the preparation of sweetened beverages with decreased sugar content while maintaining the same total sweetness which comprises replacing 100 parts of said sugar with a composition comprising up to 90 parts of sugar and maltol in an amount to provide from about 5 to about 75 p.p.m. based on said beverage.

As specific embodiments, the instant invention contemplates sweetened, acidulated compositions which contain less sugar than ordinarily used but which retain the same sweetness and acidity. Such sweetened, acidulated foods are those wherein for each 100 parts of sugar there has been substituted up to about 90 parts of sugar and maltol in an amount to provide from about 5 to about 75 p.p.m. based on said food and which also contain an acidulating quantity, i.e., from about 0.5 to about 100 parts by weight, based on said sugar, of a food acid. In addition, there are contemplated processes for decreasing the amount of sugar in a sweetened, acidulated food while maintaining the same total sweetness and acidity which comprise replacing 100 parts of said sugar with a composition comprising up to 90 parts of sugar and maltol in an amount to provide from about 5 to about 75 p.p.m. based on said food. As a further specific embodiment of this invention, there is contemplated a process for the preparation of an acidulated, sweetened beverage with decreased sugar content while maintaining the same total sweetness and acidity which comprises replacing 100 parts of said sugar with a composition comprising up to 90 parts of sugar and maltol in an amount to provide from about 5 to about 75 p.p.m. based on said food.

Maltol is a valuable gamma-pyrone which is freely available commercially. It can be prepared, for example, by the combination of fermentation and chemical synthesis processes disclosed and claimed in the U.S. Patent 3,130,204 to B. E. Tate and R. L. Miller, and assigned to the assignee of the instant application. The process disclosed in said patent generally comprises the oxidation of kojic acid, which is obtained by fermentation, to comenic acid, the decarboxylation thereof to pyromeconic acid, treatment thereof with formaldehyde to form 2-hydroxymethyl pyromeconic acid, and reduction thereof to form maltol, 2-methyl-pyromeconic acid.

The term "sugar" used herein and in the appended claims contemplates carbohydrates having a sweet taste and the general formulas, $C_nH_{2n}O_n$, $C_nH_{2n+2}O_n$ or $C_nH_{2n-2}O_{n-1}$. Among the sugars whose sweetening power is enhanced by the addition of maltol in accordance with the instant composition are, for example, fructose, invert sugar, sucrose, glucose, xylose, maltose, rhamnose, galactose, raffinose, lactose, mannitol, sorbitol, xylitol, arabitol, and the like.

The term "acidulated" when used herein and in the appended claims contemplates compositions in which the

acidity is introduced as a food acid or is contained naturally as a food acid in one of the components thereof. For example, acidulated sweetening compositions can comprise sugar plus organic acid, said organic acid being added as such, or in a component, for example, in a citrus juice. The organic food acids used for acidulation are, of course, physiologically acceptable. Special mention is made of food acids such as, for example acetic acid, malonic acid, succinic acid, fumaric acid, glutaric acid, malic acid, lactic acid, citric acid, glycolic acid, tartaric acid, gluconic acid, and the like. It will be recognized that these acids are present in many juice products and other foods which are sweetened by the addition of sugar during preparation for consumer use. For example, one or more of the food acids are naturally present in lemon juice, orange juice, pineapple juice, apple juice, wine, and the like.

An important commercial use of the process of the instant invention in the case where a pure food acid is added separately would be illustrated by the preparation of carbonated beverages and fruit-type beverages. These are ordinarily prepared by adding citric acid and sugar (usually enough to provide from 9 to 13% of the total) to the acid-containing fruit juice or flavors.

The manufacturing costs of these foods and beverages are reduced in accordance with the instant invention by replacing part of the sugar with a very small amount of maltol, as will be more fully described hereinafter.

Maltol is a crystalline substance and can be used as such or can be employed in solution in a suitable solvent such as, for example, water. The flavoring compositions contemplated can comprise mixtures of solid sugars and solid maltol or, alternatively, suitable solutions thereof. Furthermore, it is not necessary, in the practice of this process, to premix both ingredients since the addition of sugar may precede or follow the separate addition of maltol.

It will be recognized that, since the novel compositions of this invention comprise up to 90 parts sugar and maltol in an amount to provide from about 5 to about 75 parts by weight based on the food, if desired, only 5%, or more, or even less, of the sugar may be replaced in any given formulation. The amount of maltol to be employed will, of course, depend on the amount of sugar to be replaced but will fall within the stated range. Since maltol itself does not taste sweet, the instant invention does not contemplate a total replacement of sugar but rather a sparing technique where partial replacement of sugar, with attending economic advantage, is attained.

The following examples illustrate the practice of the processes of the instant invention and are not to be construed as limiting the invention in any way, many variations of which are possible without departing from the spirit or scope of the invention.

EXAMPLE I

Fresh lemonade and limeade containing 9.0 percent sugar and 15 p.p.m. maltol were prepared. Control lemonades and limeades containing 9.45% and 10.35% sugar but no maltol were also prepared. When these samples were given to a trained and experienced taste panel, the panel members matched the control and test samples as being equal in sweetness.

EXAMPLE II

Three lemonade samples are prepared with the following compositions, respectively:

	I	II	III
Fresh lemon juice, ml.	35	35	35
50% Sugar syrup (w./v.), ml.	50	45	45
Water, ml.	175	177	177
1% Maltol solution, ml.			0.4

Each of the three solutions is presented to 7 tasters; 7 out of 7 tasters judged I and III most alike; II is described as less sweet, more acid or flatter.

Thus, it is found that 10%, or 10 parts per hundred parts, of the sugar in the lemonade can be replaced with 15 p.p.m. of maltol based on the beverage, while the acid level is maintained at about 8.4 parts of citric acid per 100 parts of sugar originally taken, and there is obtained lemonade with sweetness and acid taste equivalent to the original sample.

Substantially the same results are obtained when 10 parts per hundred of the sugar are replaced with 25 p.p.m. of maltol based on the beverage.

EXAMPLE III

An acidulated, sweetened mixed fruit-type punch drink is prepared which contains 100 g. of sugar per liter of drink. A second drink is prepared containing 95 g. of sugar per liter. A third drink is prepared containing 95 g. of sugar and 0.015 g. of maltol per liter. The third drink, which contains 15 p.p.m. of maltol, is fully as sweet and acceptable as the first drink; the second drink is less sweet than the first and third. Thus, 100 parts of sugar have been replaced with a composition comprising 95 parts of sugar and $\frac{1}{6\frac{1}{7}}$ part of maltol, or, it can also be said that 5,000 parts of sugar have been replaced with 15 parts of maltol and 1 part of maltol has replaced 333 parts of sugar.

EXAMPLE IV

A mayonnaise-type salad dressing is made, which contains 1% of sugar and 1% of acid as acetic. This is used as a control in an evaluation of the sweetness and acidity of a number of dressings of the same formulation wherein up to 10% of sugar has been replaced and to which maltol has been added in an amount to provide from about 5 to about 75 parts by weight based on said dressing. It is found that the dressings containing less sugar and also containing maltol are fully equivalent to the control dressing.

A particularly efficacious combination comprises 0.95% sugar and maltol in an amount to provide 15 p.p.m. based on the dressing.

The amount of acid in the said dressing is varied from about 0.5 to about 100 parts based on the said sugar. It is found that 100 parts of the sugar can be substituted with up to 90 parts sugar and from about 5 to about 75 parts per million by weight of maltol based on said dressing and the same sweetness and acidity as the control dressing is obtained.

EXAMPLE V

A cherry-flavored beverage was prepared by adding a cherry-flavor extract in equal amounts to the following formulations:

	Sample A	Sample B	Sample C
Sucrose, grams.	13.2	11.9	11.9
Fumaric acid, grams.	0.15	0.15	0.15
Maltol, p.p.m.	0	0	50

Sample C was as sweet as Sample A and tasted sweeter than Sample B.

When 75 p.p.m. of maltol are added to Sample B, containing 10% less sugar than Sample A, it is found to taste sweeter than Sample A and sweeter than Sample C.

EXAMPLE VI

Maltol is added to a number of sugars and sugar syrups: sucrose, brown sugar, maple syrup, corn syrup, fructose, invert sugar, glycose, xylose, maltose, rhamnose, galactose, raffinose and lactose. Each of the said sweeteners has been dissolved in water in amounts corresponding to 0.33, and 0.66%, respectively. The amounts of maltol added are 75 p.p.m., and 250 p.p.m. based on total solutions. A portion of each of the said sugar solutions is reserved for use as a control.

Sweetness of the solutions is tested by presenting each to a taste panel, the members of which are requested

to state whether there is a positive sweetness, borderline sweetness, or no sweetness present. Maltol is found to definitely enhance the sweetness of the sugars. Maximum enhancement is obtained at the 75 p.p.m. level. At the 250 p.p.m. level, the taste of maltol is apparent.

When this experiment is repeated using 100 p.p.m. of maltol based on total solution, the taste of maltol is apparent.

What is claimed is:

1. A process for decreasing the amount of sugar in a food while maintaining the same total sweetness which comprises substituting up to 15% by weight of said sugar with maltol in an amount to provide from about 5 to about 75 p.p.m. by weight based on said food.

2. The process of claim 1 wherein the food is an acidulated, sweetened beverage.

3. A process for decreasing the amount of sugar in a sweetened, acidulated food while maintaining the same total sweetness and acidity which comprises substituting 100 parts by weight of said sugar with a composition comprising up to 90 parts by weight of sugar and maltol in an amount to provide from about 5 to about 75 p.p.m. by weight based on said food.

References Cited

UNITED STATES PATENTS

2,761,783	9/1956	Ferguson	99—141
3,156,569	11/1964	Griffin et al.	99—140

A. LOUIS MONACELL, *Primary Examiner.*

S. E. HEYMAN, *Assistant Examiner.*

United States Patent Office 3,446,629
Patented May 27, 1969

3,446,629

2-ETHYLPYROMECONIC ACID AS AN AROMA AND FLAVOR ENHANCER

Charles R. Stephens, Jr., East Lyme, and Robert P. Allingham, Groton, Conn., assignors to Chas. Pfizer & Co., Inc., New York, N.Y., a corporation of Delaware

No Drawing. Original application Apr. 14, 1967, Ser. No. 630,818, now Patent No. 3,376,317, dated Apr. 2, 1968. Divided and this application Oct. 26, 1967, Ser. No. 701,494

Int. Cl. A23l 1/22

U.S. Cl. 99—140 2 Claims

ABSTRACT OF THE DISCLOSURE

2-ethylpyromeconic acid and its use in improving the flavor and aroma of edibles and the aroma of perfumes.

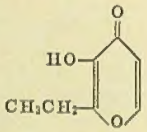
CROSS-REFERENCE

This application is a division of copending application Ser. No. 630,818 filed Apr. 14, 1967, now U.S. Patent No. 3,376,317, which was in turn a continuation-in-part of the application Ser. No. 310,919 filed Sept. 23, 1963 and now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to providing improved flavor and aroma in edibles and improved aroma in perfumes. More particularly, it is concerned with process for the improvement of flavor and aroma of foods and beverages and the aroma of perfumes which comprise the addition of 2-ethylpyromeconic acid thereto. In addition, it contemplates compositions of edibles and of perfumes which contain the said 2-ethylpyromeconic acid.

2-ethylpyromeconic acid is a gamma-pyrone of the formula:



It is an acidic substance which forms salts with bases, which salts can be used interchangeably with the free acid in the instant invention.

It is a matter of common knowledge and experience that the addition of maltol, also known as 2-methylpyromeconic acid, a valuable gamma-pyrone, to many foods improves the flavor and aroma thereof to such an extent that wide consumer acceptance of the practice has been obtained. This appreciation of improved flavor is reflected in increased sales volume of foods so treated. Furthermore, numerous taste panel tests demonstrate that many foods containing maltol are preferred over those from which it is omitted. This acceptance has been found, for example, in edibles such as beverages, confections, baked goods, and ice cream. Furthermore, maltol has been added to perfumes, which have their appeal heightened because of maltol's effect of enhancing the desirable aroma thereof.

Maltol is extremely beneficial in the replacement of certain other classical flavor and aroma enhancers in that it is generally much more powerful and, for this reason, can be used in lower amounts. An advantage in this practice is immediately obvious in that such a high strength enhancer may be used at lower levels and, as a result, the natural taste of maltol itself does not overpower the desired edible flavor and aroma or perfume aroma. For example, it is known that maltol can replace four times its weight of coumarin. Although coumarin has been used very widely in the past, it has such a powerful aroma of its own, resembling that of vanilla beans, that great care must be used to prevent so much being added as to overpower the compositions, maltol, on the other hand, is used in smaller amounts than coumarin, thus providing a margin of safety. Because of this and its lack of toxicity, maltol has replaced coumarin in many foods.

It has now been found that the compound 2-ethylpyromeconic acid, surprisingly, is very much more effective than maltol as a flavor and aroma enhancer. In fact, 2-ethylpyromeconic acid has an aroma and flavor-enhancing power of about 6 times that of maltol. Thus, on a relative basis, one part by weight of 2-ethylpyromeconic acid is equivalent to about 24 parts of the aforesaid coumarin in its flavor and aroma enhancing effect.

The advantage in using 2-ethylpyromeconic acid becomes immediately obvious after considering that the relative costs of the said 2-ethylpyromeconic acid and of maltol are of approximately the same order of magnitude. Thus, the consumer is able to use only about one-sixth as much of the 2-ethylpyromeconic acid to achieve the same level of flavor and odor enhancement and realizes very significant savings in manufacturing cost. Furthermore, because of its effectiveness at such low concentrations, effects not possible to achieve with maltol are observed with 2-ethylpyromeconic acid.

It is, therefore, an object of the instant invention to provide means of enhancing the flavor and aroma of edibles and the aroma of perfume, said means being achieved with a substantial decrease in cost as compared with commonly employed means.

It is a further object of the instant invention to provide edible compositions with enhanced flavor and aroma, said compositions being obtained at substantially less cost than those of the prior art.

It is a further object of the instant invention to provide perfume compositions, said compositions having enhanced aroma and being obtained at substantial cost savings over perfume compositions of the prior art.

It is a still further object of the instant invention to provide means for enhancing the flavor and aroma of edibles and the aroma of perfumes, said means not contributing any appreciable, undesirable flavor and aroma of its own to the edibles and perfumes.

These and other objects of the instant invention are readily achieved through use of the process of this invention which, in essence, comprises enhancing the aroma of edibles and perfumes and the flavor of edibles by adding 2-ethylpyromeconic acid thereto.

With respect to enhancing the aroma and flavor of edibles, particular mention is made of the especially desirable increase in appeal which is obtained when 2-ethylpyromeconic acid is added in an amount to provide from about 1 to about 100 parts per million by weight. It is observed that below about 1 part per million there is a tendency for some of the test subjects to have difficulty in discerning the beneficial effect of the addition and that above about 100 p.p.m., some of the subjects begin to notice an aroma effect contributed by the 2-ethylpyromeconic acid itself. It is obvious to those skilled in the art to which this subject matter pertains that for varying purposes varying amounts are required, which may be determined by experimentation. Thus, in some products the test subjects have difficulty in discerning 5 p.p.m. and also in some products less desirable effects are observed above about 100 p.p.m. With respect to enhancing the aroma of perfumes, generally, the same levels of 2-ethylpyromeconic acid, as in food, can be employed. As will be understood by thse skilled in the art, the precise amount of 2-ethylpyromeconic acid to be added will depend on the desired strength of the perfume odor itself. It is found especially convenient to substitute about ⅛ part by weight of 2-

ethylpyromeconic acid for each 1 part by weight of maltol in those formulations wherein maltol is a component. Since, at the present time, maltol costs about $12 per pound; substantial savings may be obtained through the substitution of 2-ethylpyromeconic acid for maltol.

2-ethylpyromeconic acid is a novel gamma-pyrone which is readily prepared by a process which is the subject of a copending application, Ser. No. 310,141, filed Sept. 19, 1963, now abandoned, by B. E. Tate and R. P. Allingham and assigned to the assignee of the instant invention. As is disclosed in said copending application, 2-ethylpyromeconic acid is prepared readily and economically by a combination of a fermentation technique and organic synthesis. The starting material for the said synthesis in kojic acid and the process generally comprises the steps of oxidizing kojic acid to comenic acid, of decarboxylating said comenic acid to pyromeconic acid, of treating said pyromeconic acid with acetaldehyde to form 2-(1-hydroxy)ethylpyromeconic acid, and reducing this to 2-ethylpyromeconic acid.

With respect to the term "edibles," used herein and in the appended claims, it is contemplated to include compositions which are ordinarily eaten or drunk. For example, 2-ethylpyromeconic acid is a powerful flavor and aroma enhancer for chocolate and vanilla products, candies, ice cream, cake mixes, cookies, pies, desserts, fruit juices, wines, liqueurs and flavor extracts. Furthermore it can be used as a flavor and aroma component in canned and frozen fruits and vegetables, meat and fish products, cereals, macaroni and noodle products, soups, sauces and seasonings, prepared dressings, and breads. In addition, among the edibles which can be benefited by the process of the instant invention are pharmaceutical oral dosage forms, animal feeds and pet foods. With respect to the term "perfumes," as used herein and in the appended claims, it is meant to contemplate concentrated essences, colognes, and industrial odorants which are commonly used in cosmetc and hygienic products, such as detergents and soaps, and in the perfuming of tobacco, paper, textiles, printing inks, food packages, paints, home deodorants and insecticides.

As has been mentioned hereinbefore, 2-ethylpyromeconic acid at a very low level strengthens the flavor and aroma of a wide variety of products. It develops inherent flavors and creates, especially in sweet foods, a "velvet mouth sensation." Because it so strongly augments many inherent flavors, as for instance, that of chocolate, product reformulation may be required in some instances to achieve optimum taste; these reformulations are well within the capability of those skilled in the art. 2-ethylpyromeconic acid may be added to the food or perfume directly in the dry form or, alternatively, as a solution. Care should be taken to obtain even distribution through the use of pre-mixing if necessary, since such small quantities have such a powerful effect.

The following specific examples illustrate the practice of the invention, but are not to be construed as limiting the invention to the foods specifically disclosed.

EXAMPLE I

Aqueous solutions of 2-ethylpyromeconic acid and of maltol are serially diluted and matched as to odor intensity. It is found that 2-ethylpyromeconic acid has an aroma 6 times as strong as that of maltol. Furthermore, this effect is noticed at a considerably lower concentration than that previously recorded for maltol.

EXAMPLE II

2-ethylpyromeconic acid is added to chocolate bars by melting the bars and incorporating into one sample 20 p.p.m. and into another 40 p.p.m. The bars are recast and are tasted and compared with chocolate to which no 2-ethylpyromeconic acid has been added. It is found that the 2-ethylpyromeconic acid increases the rickness of the chocolate flavor and creates a blended taste by evening off harsh chocolate notes and lifting the aroma, as compared with the control.

EXAMPLE III

2-ethylpyromeconic acid is added to a commercial yellow cake mix at 4, 13, 25, 41, 80 and 100 p.p.m., based on dry weight. The cakes are prepared according to label direction. There is also prepared a control cake, which does not contain 2-ethylpyromeconic acid. 2-ethylpyromeconic acid added at 13 p.p.m. appears to give the best enhancement of aroma and flavor. For all the cakes, those containing 2-ethylpyromeconic acid are superior to control.

Commercial angel food cake mix is given an increased taste appeal by the addition of 40 p.p.m. of 2-ethylpyromeconic acid. Since the flavor of presently available angel food cake mixes is rather bland, the addition of 2-ethylpyromeconic acid provides a means for improving this product.

A pineapple cake mix is similarly tested with 40 p.p.m. of 2-ethylpyromeconic acid and is more attractive in flavor and aroma than the control.

A coconut macaroon mix containing 40 p.p.m. of 2-ethylpyromeconic acid is baked yielding a richer-tasting cookie with a stronger coconut flavor and smoother mouth feel than the control. During mixing, the coconut aroma is more evident in the cookie mixture containing the 2-ethylpyromeconic acid.

EXAMPLE IV

A chocolate fudge is prepared containing 2-ethylpyromeconic acid and is compared with a control; the basic creme fondant is prepared containing 40 p.p.m. of 2-ethylpyromeconic acid. The 2-ethylpyromeconic acid strongly reinforces the chocolate flavor and the product is judged to have a more pleasant fragrance.

Creme candies are prepared containing 20 p.p.m. of 2-ethylpyromeconic acid; they are found to have significantly better flavors than those which do not contain the said acid.

EXAMPLE V

Pineapple juice flavor is pleasingly enhanced when 2-ethylpyromeconic acid is added at 4 p.p.m., and compared with a control.

Ten p.p.m. of 2-ethylpyromeconic acid added to grape juice greatly amplifies the natural sweet grape aroma.

Five p.p.m. of 2-ethylpyromeconic acid in sherry wine provides an improved flavor; 10 p.p.m. of 2-ethylpyromeconic acid creates a pleasant change in bouquet.

The flavor of an orange-type liqueur is sweetened by the addition of 10 p.p.m. of 2-ethylpyromeconic acid to said liqueur.

The fruit flavor of a low calorie orange drink is enhanced by adding 1 p.p.m. of 2-ethylpyromeconic acid thereto.

EXAMPLE VI

2-ethylpyromeconic acid is dissolved in a floral base cologne to provide 4, 8, 10, 25, 50, 75, 100 and 250 p.p.m., respectively. The odors of the resulting perfume compositions are determined and compared with that of the untreated perfume as a control. The aromas of the 2-ethylpyromeconic acid-containing perfumes are significantly enhanced.

EXAMPLE VII

2-ethylpyromeconic acid alone is added to a perfume base solvent at 10 p.p.m. When this is sprayed into an area it provides a pleasant cotton-candy like aroma.

EXAMPLE VIII

Ethyl maltol, propyl maltol and maltol were evaluated as to their taste and odor characteristics by a professional flavor chemist having nine years' experience in food and perfume chemistry.

Protocol

Three solutions were prepared containing respectively, 100 p.p.m. of maltol (2-methylpyromeconic acid), ethyl maltol (2-ethylpyromeconic acid), and propyl maltol (2-propylpyromeconic acid) in 25% ethanol-water. Each solution was further diluted with water to levels of 500, 200, 100 and 10 p.p.m. Each of the twelve samples was evaluated as to odor and odor intensity.

Conclusion

The flavor chemist concluded that (1) the sample containing 500 p.p.m. maltol had about the same level of odor intensity as the sample with 100 p.p.m. ethyl maltol. (2) The sample containing 10 p.p.m. ethyl maltol had an odor intensity stronger than the sample containing 100 p.p.m. propyl maltol but less intense than the sample containing 100 p.p.m. maltol. (3) Ethyl maltol containing samples had an odor character similar to maltol but more intense, sweeter and more desirable than the odor of maltol.

EXAMPLE IX

The flavor chemist of Example VIII evaluated ethyl maltol, propyl maltol and maltol as to their flavor and odor intensities when contained in a strawberry beverage.

Protocol

A strawberry beverage was prepared according to the following formulation:

Strawberry beverage—	Percent
Sugar	8.40
Citric acid	0.14
Water	91.21
Strawberry flavor	0.25
	100.00

Strawberry flavor	Grams
Vanillin	0.10
Ethyl butyrate	0.35
EMPG[1]	1.00
Strawberry coeur	0.50
Ethyl alcohol	98.05
	100.00

[1] Ethyl methyl phenyl glycidate.

To four 200-gram samples of the strawberry beverage were added, respectively, 100 p.p.m. maltol (A), 20 p.p.m. ethyl maltol (B), 100 p.p.m. propyl maltol (C), and 500 p.p.m. propyl maltol (D). A fifth 200-gram sample was used as a control beverage (E) i.e., it contained no maltol of maltol analog. The samples were tested by the flavor chemist.

Results

The flavor chemist indicated the following samples were of the odor and flavor intensities indicated:

Sample A stronger than C
Sample A stronger than E
Sample B equal to A
Sample B stronger than C
Sample B stronger than E
Sample C equal to E
Sample D has a predominant off taste.

Conclusion

The flavor chemist concluded from the results of his tests that

(1) The two beverage samples containing 20 p.p.m. ethyl maltol and 100 p.p.m. maltol, respectively, proved to have an outstanding strawberry flavor, superior in strength to the control beverages and to the beverage containing 100 p.p.m. propyl maltol.

(2) The strawberry beverage containing 20 p.p.m. of ethyl maltol had a strawberry flavor equally as intense as the strawberry beverage containing 100 p.p.m. maltol.

(3) A beverage containing 100 p.p.m. propyl maltol proved to have a comparable taste to the control beverage and thus showed no advantageous effect.

(4) A beverage containing 500 p.p.m. propyl maltol was found to have a predominant off taste and thus to have an undesirable effect.

EXAMPLE X

A strawberry beverage was prepared according to the formulation of Example IX. The control beverage was divided into three parts. To one part was added ethyl maltol in an amount to give a 20 p.p.m. concentration in the beverage. To the second part was added maltol in an amount to give 20 p.p.m. concentration in the beverage. The third part was used as a control and contained no maltol or ethyl maltol.

Each sample was compared by the flavor chemist of Example VIII. He concluded that sample containing 20 p.p.m. ethyl maltol had a stronger, more intense and more natural taste than did the sample containing 20 p.p.m. maltol. The control sample had a taste, less intense than the samples containing either 20 p.p.m. of ethyl maltol or 20 p.p.m. of maltol.

EXAMPLE XI

Two taste panels of specially selected members each of whom had previously shown a particular sensitivity to variations in the taste and aroma of foods, were brought together for the purpose of comparing the effect of maltol, ethyl maltol and propyl maltol in foods.

Part A

A triangle panel evaluation of maltol and with propyl maltol was conducted using five judges who had each previously participated in similar test programs and who were familiar with the psychophysical procedure of sensory panel evaluations.

Protocol

Each panel member was given three samples, designated No. 1, No. 2 and No. 3, and asked to taste each and determine which was the odd sample and which two were alike, and to state his preference of the three samples.

Test Samples

The strawberry beverage control prepared according to the formulation of Example IX was used. To samples No. 1 and No. 3 of the control beverage were added sufficient propyl maltol to give 100 p.p.m. of propyl maltol. To sample No. 2 was added maltol in an amount to give 100 p.p.m.

RESULTS

Taster	A	B	C	D	E
First preference	(1), 3	2	2	2	1
Second preference	2	1,3	1,3	1,3	2,3
Like samples	1,3	1,3	1,3	1,3	2,3
Odd sample	2	2	2	2	1

Descriptive phrases used by the tasters for the samples:

Propyl maltol sample—"not as sweet," "slightly bitter," "more flat," and "not fruity."

Maltol sample—"more sweet," "more fruity," and "more pronounced strawberry flavor."

Conclusion

Four out of five tasters selected the odd sample correctly. Three of these four tasters preferred the taste of

the sample containing maltol to the sample containing an equal amount of propyl maltol.

Part B

A skilled and well-qualified taste panel of seven members was brought together. Each member was experienced in testing the flavor and aromas of foods, food additives and flavor and aroma enhancers. The panel was asked to select the more flavorful of two blind samples of a strawberry gelatin dessert. An eighth panel member was asked to participate during the latter part of the testing.

Protocol

Flavor testing was conducted over a period of five days in a specially constructed flavor panel room provided with red lights to prevent the panelists from discerning the color of the samples. Each panelist's booth was individually partitioned. The testing room was air-conditioned and free from noise and distractions. A period of about three hours was allowed between the time an individual panelist made one judgment regarding a pair of samples and his next judgement on another pair of samples. Drinking water and a bland cracker were available for each panelist, in the event he believed he could still taste the first sample before tasting the second sample of a pair. Each pair of samples consisted of a sample containing maltol and a sample containing ethyl maltol. The samples were randomized in the sense that during any one testing period, half the panelists were given the maltol sample first and half were given the ethyl maltol sample first. Panelists were asked to mark their preference on a ballot.

Test samples.—Control

To 85 grams of a strawberry-flavored gelatin dessert powder base was added 30 mg. of maltol. The powder mixture was stirred and blended with 1 pint hot water and allowed to cool and gel. The strawberry-flavored gelatin dessert powder base was a commercial formulation containing only sugar, strawberry flavor and gelatin.

Samples

Samples of strawberry-flavored gelatin dessert containing ethyl maltol were prepared by adding varying amounts of ethyl maltol to 85 gram lots of the strawberry-flavored gelatin dessert powder base. One pint of hot water was added to each sample and the samples were allowed to cool and gel.

Formulation

Strawberry-flavored gelatin dessert powder base	85 grams.
Water	1 pint.
Additive	As indicated in table.

Sample No.	Additive	Amount (mg.)	Ethyl maltol level [1]
1	Maltol	30	0
2	Ethyl maltol	15	½
3	do	10	⅓
4	do	7.5	¼
5	do	6.0	⅕
6	do	5.0	⅙
7	do	4.3	⅐
8	do	3.8	⅛
9	do	3.3	⅑
10	do	3.0	1/10

[1] Level of ethyl maltol in sample compared to level of maltol in sample 1.

Summary of results

Level of ethyl maltol as compared to maltol level:	Number of panelists preferred ethyl maltol sample
½	7–7
⅓	6–7
¼	7–7
⅕	6–7
⅙	4–7
⅐	4–7
⅛	0–8
⅑	1–8
1/10	1–8

Conclusion

Maltol, when added to a strawberry-flavored gelatin dessert, gives a less flavorful product than does a gelatin dessert to which is added ethyl maltol at levels of from ½ down to about ⅕ those of maltol in the maltol-containing dessert.

What is claimed is:

1. A method for enhancing the aroma and flavor of edibles which comprises adding from about 1 to about 100 p.p.m. by weight of 2-ethylpyromeconic acid thereto.

2. Edibles containing from about 1 to about 100 p.p.m. by weight of 2-ethylpyromeconic acid as a flavor and aroma enhancer.

References Cited

UNITED STATES PATENTS

2,955,041	10/1960	Broderick et al.	99—140
3,130,204	4/1964	Tate et al.	99—140
3,156,569	11/1964	Griffin	99—140

RAYMOND N. JONES, *Primary Examiner.*

H. H. KLARE III, *Assistant Examiner.*

U.S. Cl. X.R.

99—1, 35, 86, 80, 100, 107, 136, 144